PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited,

167-177 TIMES BUILDING, NEW YORK.

Established 1874. Incorporated 1889.

W. J. JOHNSTON, Prest. C. E. STUMP, Treas. and Bus. M'g'r.

Telephone Call: Murray 586. Cable Address: "Electrical," New York.

T. COMMERFORD MARTIN and JOS. WETZLER, M. E., Editors.

WM. A. ROSENBAUM, Editor Patent Department.

WALTER T. HUNT, Advertising Department.

New England Office, 8 Cook Building, Boston.
Western Office, 39 Mallers Building, Chicago.
Philadelphia Office, 31 City Trust Building.

SUBSCRIPTION, IN ADVANCE, ONE YEAR, $3.

(Including Postage in the U. S., Canada or Mexico.)

IN CLUBS of four or more, $2.50 a year each; with a free extra copy to the getter up of a club of 8. Foreign subscription, $5 a year.

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Matter for the **Editorial** Department should be addressed to
The Editors of The Electrical World New York
Subscriptions and communications relating to **advertising** or the **business department** should be addressed to

THE W. J. JOHNSTON COMPANY, Ltd.,
Times Building, New York
OR ANY OF THE BRANCH OFFICES.

AND "THE ELECTRICAL WORLD" IN THE UNITED KINGDOM

Arrangements have been made by which the London "Electrician" can be obtained from THE ELECTRICAL WORLD *office, 167-177 Times Building, New York.*

The rate of subscription (payable in advance), including postage, is $6 per annum to any address in the United States, Canada, Mexico or other foreign country.

Single copies, price 10 cents, can also be obtained at THE ELECTRICAL WORLD *office. Similarly* THE ELECTRICAL WORLD *can be obtained in England at the office of* The Electrician, *1 Salisbury Court, Fleet Street, London, E. C.*

The rate for English or foreign subscribers (payable in advance, £1. 1s

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VOL. XIV. NEW YORK, AUG. 17, 1889. No. 7.

Our Convention Issue. THE present issue of THE ELECTRICAL WORLD, giving a full report of the Niagara Falls meeting of the National Electric Light Association, will be found of great interest and value. It is worthy of note that the issue is no less than **8** pages larger than the corresponding issue of last year, although that covered the great meeting then held in this city. It is thus that THE ELECTRICAL WORLD grows, and strengthens with its growth, more than holding its own as the representative electrical journal of America.

Economic Size of Line Wire. IN the early days of the arc light it was considered that any size of copper wire which would carry the current and be sufficiently strong to "stand up" was the proper one to use for arc circuits; but the time soon came when, with the increase in the length of the circuits, it was found that the loss entailed in the conductors was an appreciable factor; and the result has been that larger sizes of wire are used as a measure of economy. In the short paper presented by Mr. B. Rhodes before the association, this question of the most economic size of line wire for constant current is very well canvassed, and an excellent method of calculating it is developed. The formula brings out the fact that the diameter of the wire depends on the price of copper, cost of power and quantity of current, and is entirely independent of the length of the circuit, and, in this case, of the voltage. The formula agrees with Sir Wm. Thomson's rule for the most economical size of conductor, and also with the theory of Deprez that the diameter is independent of the length of the circuit. It must be borne in mind, however, that this formula applies only to constant current circuits in which the loss in the conductors is a constant quantity at all times, independent of the voltage at which they may be working. It does not apply to constant potential circuits, in which the loss in the conductors varies with every change in the current transmitted.

The World's Fair Representative. IT is not a little unfortunate that in hastening to support Mayor Grant in his preliminary work for the World's Fair, to be held in this city in 1892, the different electrical bodies in this city or of national scope have each selected a representative on its own account. Mayor Grant asked each industry or scientific interest to combine on one man for his general committee. Thereupon the National Electric Light Association wisely chose one of its most popular and able representatives, Dr. Otto A. Moses, who, it was already known, had been indorsed by Mr. Edison. The Board of Electrical Control of New York, however, put forward Mr. Jacob Hess, the politician; the American Institute of Electrical Engineers chose a young and energetic member of its council, Dr. F. B. Herzog, who is also supported by President Crocker of the New York Electrical Society; and the New York Electric Club has wound up the list by entering Mr. Theodore N. Vail and Mr. H. C. Davis, both of whom are too highly respected to need any eulogy on our part. Here, certainly, is diversity of talent, but it is a great pity that no one man has received such an indorsement as would render his selection by the mayor simply an act of graceful acquiescence. The mayor is now left to make a choice of his own, and it is but too seriously to be feared that he will be moved to select Commissioner Hess. In that event, the best thing the electrical interests can do is to enter a protest by uniting, as they should have done at first, upon a man who has at least some claims upon the electrical community, and by insisting that he shall be their sponsor.

Central Station Construction. THE two papers read before the convention on central station construction are both characterized by the strong stand taken by their authors in favor of the slow-speed over the high-speed engine for central station work. The discussion raised on this point was of much the same character as that which has already taken place at other meetings of the association, and the conflict seems as yet far from being settled, as even those who have used both types of engine disagree in their opinions as based on the results of experience. Mr. Law describes the "perfect" station, such as it ought to be, and gives a number of valuable suggestions, which may be applied with profit to many existing stations. Messrs. Remington and Henthorn have laid before the association a paper which must be conceded to be the most complete of its kind thus far presented. Starting out with the concession that the best is the cheapest, they have worked out plans that must command admiration. Whether or not the expectations of the designers as to fuel consumption will be reached, the many other points of excellence and economy everywhere noticeable cannot fail to make this station a paying one if properly managed, and of this there seems little doubt. The wealth of detail embodied in the paper and its accompanying illustrations places at the disposal of all a guide of great value, and Messrs. Remington and Henthorn deserve the thanks of the entire electrical community for the spirit of liberality shown in thus presenting them with what must certainly have involved much labor and expense. The station described is not only a credit to its designers, but to those also who have afforded them the means to carry their plans into execution.

Station Statistics. MR. A. R. FOOTE, who has already rendered the association excellent service as Chairman of the Committee on State and Municipal Legislation, has again proved the great interest which he takes in its welfare in the paper presented at this meeting. The arguments he advanced in support of his resolution for the appointment of a committee on station statistics are incontrovertible, as they are self-evident. As remarked by several members in the discussion of Mr. Foote's paper, it was for just such objects that the association was founded, and the neglect which has thus far been shown in this direction must no longer be allowed to continue. Not the least powerful argument in favor of collecting such statistics is, that by its means the membership of the association may be augmented; and though a healthy increase in numbers was shown since the last meeting, the association has still a large field to work, from which members can be drawn. The fears existing in the minds of some that the collection of such statistics might be greatly interfered with by the reluctance to furnish what might be considered private matters of business, are hardly to be considered as of sufficient weight to make it impracticable. Even if individual companies should withhold certainthings which they may consider of a private nature, there would still be left many points upon which they would not refuse to give the results of their experience, and which would be of value. Statistics in order to be of any value, however, must be well digested, and in this matter the committee having the work in charge cannot be too careful. When we consider the great diversity of location of the various stations, involving so many different local factors, it becomes apparent that the statistics gathered must be carefully sifted in order to avoid the drawing of false conclusions. However, in the hands of Mr. Foote and his able assistants, we are certain that the work will receive careful attention, and we hope that at the next meeting the committee will be able to show that a good start has been made in this direction.

The Electric Light Convention. A LARGE portion of our space this week is naturally devoted to the report of the proceedings of the National Electric Light Association at Niagara Falls. The report is given with customary fullness, and it will be seen that in many respects the meeting was one of great interest and importance. The papers presented were certainly far above the average in excellence. Those by Mr. Law and Mr. Henthorn and colleague on central stations are worthy of high praise, as full of valuable hints and information, and they will be welcomed by all engaged in the industry. So, too, it is safe to say that a better paper on electric railways than that by Mr. Geo. W. Mansfield has never been brought before any society in this country. It is replete with statistics, and is throughout strong and convincing. Professor Roberts' paper on the electrical transmission of power is also weighty, and we would recommend it for careful perusal. The papers of Mr. Haskins and Mr. Bracken were also good, and should be read by all; while the statistical work of Mr. Foote, and that of Mr. P. H. Alexander in regard to insurance, is of the kind that wins approval in every quarter. The action desired by Mr. Lynch in standardizing the potential of electrical railways would be timely, and we trust that the point will be carried as soon as possible. It would be difficult to say how many potentials are now used in lighting, and, unless some steps are taken, electric railway work will ere long be cursed by the same want of uniformity in the veriest essentials. As to the resolutions adopted in regard to electrical execution, we think they will meet the general sentiment. If there are any very considerable number of electrical men seeking to have electricity used for death-dealing purposes, we have yet to meet them. Another important matter to which the association gave its attention was the New York World's Fair. We believe that in selecting Dr. Moses as chairman of its committee, the association chose a man of unusual fitness for the post, one whose energy, versatility, *savoir faire*, and general acquaintance with electrical men and matters give him special recommendations for the arduous task of combining and directing the various elements that must be harmonized in making the electrical features of the great exhibition a success. In respect to its new constitution, the association seems to have made a regrettable but not vital mistake. While we approve heartily of the general principle embodied in the new document—that of giving proper prominence to the local lighting interests—we have yet to be convinced that the constitution was adopted, as required by a two-thirds vote of those present; and until it has been so adopted, it would certainly not appear to be operative. And even if it be decided that it was so adopted, there arises grave doubt as to the constitutionality of an action which invalidates the contract entered into by the association with its individual members at the beginning of the year, when, giving them all the rights of active membership, it accepted their dues, which the old constitution expressly pledges "shall cover the calendar year." Nevertheless, while there was undue precipitancy and, perhaps, irregularity, in the movements that thus brought affairs to their present situation, the general will of the body was unquestionably voiced in the letters that caused the special committee to formulate the new constitution it submitted; and, in the long run, the supply members will probably ratify the rulings by giving the association their help, influence and membership more largely than before It would be wise, however, we think, to let the supply men select their own representatives for the executive committee; but if still further changes in the constitution are to be made, it may be well to hire some professional Abbe Sieyes, or some lawyer who gives these matters his special thought, to put the constitution in such shape that hereafter no man can be disfranchised or disqualified without his full knowledge and free consent. The association is so useful, and has in it the promise of so much good work for electric lighting, that it behooves us one and all to seek its welfare. As it stands to-day, with a good record, solid finances, a respected president, and a growing membership, it is an institution that each one in any way connected with it should be proud to build up

Tenth Convention—Semi-Annual Meeting of the National Electric Light Association,

The tenth convention of the National Electric Light Association was held at the Casino, Niagara Falls, N. Y., Aug. 6, 7 and 8, 1889.

The following gentlemen were in attendance:

Albany, N. Y.—E. A. Maher.

Altoona, Pa.—W. H. Markland.

Ansonia, Conn.—C. H. Cone.

Auburn, N. Y.—J. A. Seymour.

Baltimore, Md.—J. Frank Morrison.

Binghamton, N. Y.—W. H. Parker.

Boston, Mass.—P. H. Alexander, F. E. Alexander, S. E. Barton, F. E. Barker, W. W. Castle, H. B. Cram, F. A. Crawford, H. E. Duncan, H. A. Eustis, C. S. Haley, D. Killicut, G. R. Lean, J. H. Mason, E. R. Metcalf, F. E. Pettingell, A. C. Pond, C. M. Ransom, Frank Ridlon, R. F. Ross, W. P. Sayers, E. B. Williams, Alex. P. Wright, F. A. Wyman.

Bridgeport, Conn.—J. M. Orford.

Brooklyn, N. Y.—C. J. Field, E. F. Peck, D. M. Ressequie, C. R. Richards, Geo. R. Turnbull, E. T. White.

Buffalo, N. Y.—M. A. Buell, D. H. Darrin, Dr. Fell, C. R. Huntley, C. Webber, W. T. Wilson.

Cedar Falls.—F. E. Pritchard.

Chicago, Ill.—J. B. Allan, G. L. Beetle, D. S. Bloomingston, C. A. Brown, George Cutter, F. E. Degenhardt, F. DeLand, E. Gabel, H. A. Glasier, W. G. Halm, C. C. Haskins, Alex. Kempt, W. A. Kreidler, C. H. Rudd, J. H. Shay, G. M. Smith, H. H. Small, C. H. Wilmerding.

Cincinnati, O.—W. H. Calvert, H. E. Cook, L. W. Davis, A. R. Foote.

Cleveland, O.—S. E. Cox, J. B. Crouse, W. S. Culver, —— Decker, Webb C. Hayes, C. W. Hill, W. H. Lawrence, L. B. Le Vake, G. Pfannkuche, E. P. Roberts, J. S. Scoville, S. F. Smead, C. D. Smith, H. A. Tremaine, A. J. Webber, C. F. Wright.

Cuyahoga Falls, N. Y.—E. G. Babcock, C. A. Babcock, E. D. Schmidt.

Davenport, Iowa.—H. Anderson.

Dayton, O.—F. A. Brooks, —— Temple.

Detroit, Mich.—J. E. Lockwood, Fred H. Whipple.

Elmira, N. Y.—S. M. Blake.

Erie, Pa.—F. H. Ball.

Fitchburg, Mass.—H. F. Coggeshall.

Ft. Wayne, Ind.—J. H. Bass.

Fremont, O.—D. A. Ranck, C. Richmond.

Hamilton, Ont.—R. M. Gardner.

Hartford, Conn.—A. L. Foster.

Hulberton, N. Y.—F. S. Alderson.

Jersey City, N. J.—W. H. Bache.

Kansas City, Mo.—M. E. Bates, C. R. Rusling, E. R. Weeks.

Little Falls, N. Y.—G. M. Lee.

Lockport, N. Y.—F. A. Douglas.

Manchester, Conn.—W. A. Anthony.

Minneapolis, Minn.—S. S. Leonard.

Montpelier, Vt.—E. D. Blackwell.

Nashville, Tenn.—Robert L. Morris.

Newark, N. J.—C. McIntire.

New Britain, Conn.—T. H. Brady.

New Haven, Conn.—H. R. Besse.

New Orleans, La.—C. H. Black.

New York.—P. C. Ackerman, G. D. Allen, E. P. Atkinson, A. Barthmann, H. C. Barney, C. R. Botsford, W. L. Candee, R. Coleman, R. B. Corey, W. F. Cullen, F. C. Dumas, J. B. Edson, C. J. Field, G. H. Fisher, A. V. Garratt, J. W. Godfrey, M. W. Goodyear, R. J. Gray, P. H. Hover, D. Hyman, C. F. Johnson, J. F. Kelly, W. C. Kerr, F. E. Kinsman, Z. Latshaw, H. P. Lucas, H. L. Lufkin, E. T. Lynch, Jr., Geo. T. Manson, W. H. McGrath, J. P. McQuaide, T. C. Martin, O. H. Merrill, Dr. Otto A. Moses, W. C. Palmer, Geo. M. Phelps, H. W. Pope, Chas. W. Price, H. A. Reed, S. Rosenstamm, W. P. Sayles, C. A. Schieren, Jr., T. L. Scoville, J. H. Seymour, P. K. Stern, C. E. Stump, H. M. Swetland, J. B. Taltavall, W. H. Temple, C. R. Vincent, B. R. Western, Joseph Wetzler, W. C. Wonham, J. H. Williamson, F. W. Wilkins, A. P. Wisner.

Niagara Falls.—W. C. Ely, B. Rhodes.

Norfolk, Va.—J. C. Belote.

North East, Pa.—A. L. Daniels, C. A. Hitchcock.

Ogdensburg, N. Y.—J. H. Findlay.

Parkersburg, W. Va.—C. C. Martin.

Peoria, Ill.—L. Cole.

Philadelphia, Pa.—A. J. DeCamp, R. O. Heinrich, M. D. Law, G. S. McQuade, George F. Porter, J. A. Pentz, J. F. Ryan, T. C. Smith.

Pittsburgh, Pa.—S. A. Duncan, J. A. E. Hoeveler, J. W. Marsh, Nikola Tesla, F. G. Waterhouse, H. E. Webb.

Providence, R. I.—J. T. Henthorn.

Red Creek, N. Y.—W. E. Mack.

Rochester, N. Y.—C. B. Griffith, J. A. Olmstead, Geo. A. Redman.

Rutland, Vt.—M. J. Francisco.

St. Louis, Mo.—P. C. Burns, R. Parker, D. R. Russell, Charles A. Taylor.

Springfield, Mass.—L. W. Besse.

Suspension Bridge, N. Y.—G. Haeberle.

Syracuse, N. Y.—A. P. Seymour.

Toledo, O.—C. R. Faben.

Toronto, Ont.—Thos. Cooper, W. J. Morrison, H. S. Thornberry, J. J. Wright.

Trenton, N. J.—W. E. Frick.

Washington C. H., O.—Jerome Penn.

Wheeling, W. Va.—John A. Garden.

Windsor, Conn.—M. E. Baird.

Worcester, Mass.—C. D. Smith.

Yonkers, N. Y.—C. S. Bradley.

The convention was called to order Tuesday, Aug. 6, 1889, at 10:30 A. M., by President Weeks, who addressed the convention as follows.

Gentlemen: We are met primarily to further the interests of local companies; secondarily, to aid in the general development of the business and to promote the good of manufacturers of electrical apparatus and supplies. Our association combines both the commercial and scientific elements, and its deliberations are of a theoretical, as well as a practical nature. Our chief work lies in calling attention to the needs of the business and to available improvements. In this convention are represented industries which embody the very forefront of progress, yet many of you come from lands where electric light and power interests have no legal status, or are struggling under adverse enactments. I trust that the work of the committee on State and Municipal Legislation will be so seconded that we shall soon be accorded just legal recognition.

While the arc light business is steadily increasing, the greatest development has been, and must continue to be, in other directions. The superiority of the incandescent light as a supplement to the arc, is now more generally acknowledged; but owing to the commercial value of the residual products in the manufacture of gas, the incandescent light cannot compete with it in the matter of price. Without a perfect subway system and storage battery, it cannot be so reliable.

The Committee on Underground Conduits and Conductors will report progress and ask for more time. It should not be inferred from the absence of this topic from our programme that its importance has been overlooked, or that nothing is being done in the direction of electrical subways. Hundreds of thousands of dollars are being expended in experimental work; but many years must elapse before a complete solution can be reached.

The outlook for the alternating current is encouraging. More exact work is being done in this direction; and the invention of meters and motors for this current has added greatly to its commercial value. The meters recently brought out should be of the greatest advantage. It is a fundamental principle that every business of any stability measures its commodity; and customers are more confident of their service when they know that it is being measured.

We may feel gratified that our electrical apparatus is in demand in foreign countries, but this should not blind us to the fact that the criticisms of European engineers upon our streets and station construction are just. It is a hopeful sign, however, that both local and parent companies are paying more attention to good apparatus and the proper construction of lines and planning of stations. This becomes more necessary as business increases, and the price of coal advances, rendering a reduction in fuel all important. The increase in boiler pressure, and the compounding of engines, are steps in this direction. Schools, colleges and larger electrical companies, are paying more attention to electrical education. Popular articles on the applications of electricity are informing the general public as to the extent and value of our industry. With greater efficiency in apparatus, better trained men and more intelligent management, depreciation will be reduced, the conservatism of investors toward electrical securities will disappear, and capital will seek us.

Probably no other topic upon our programme will attract more general attention than the "Unconstitutionality of Electrical Execution." Whatever may be the opinion of scientists in regard to this mode of taking life. the whole movement is encouraging, in that it evinces the world's progress in sensibility.

One of the most important questions that will engage your attention at this session will be the report of the Committee on Harmonizing the Electrical and Insurance Interests. It is a matter of deep concern, not only to the producer, but to the consumer of electricity, that the electrical and insurance companies co-operate. To harmonize these interests will be to give one of the strongest impulses to electrical industries.

Electric welding is winning its way to a commercial basis, and is destined to occupy an important place in mechanics. But by far the greatest activity at present is in the direction of the transmission of power. The electric motor is working a complete revolution. It is impossible to forecast its future. The field of the stationary motor is practically infinite, and is almost virgin soil, while the mileage of roads now operated by electricity, though rapidly increasing, is still so small, compared with the total railroad mileage, as to barely suggest immense possibilities.

Statistics collected by our secretary show that the number of arc lamps in service in the United States alone during the last six months has increased from 219,924 to 237,017; that of the incandescent lamps from 2,504,490 to 2,704,768; the number of street railroads operated by electricity is now 109, comprising 575 miles of track and 936 motor cars. The capital now invested in these industries amounts to $275,000,000. These facts bring most forcibly to our attention the financial importance of the interests which we are here to represent, and should impress deeply upon the mind of each member his individual responsibility and the necessity for doing his utmost, both by regular attendance and close attention to the work in hand, to accomplish the objects for which we are assembled.

At the conclusion of his address, the President introduced Hon. W. C. Ely, of Niagara Falls, who delivered the address of welcome, of which the following is an abstract:

You are experimenters with power and force, you deal in it, you generate it, utilize it and profit by it. The item of profit is a stimulus to your brains and energy. You are the devotees of a force, the latest, the most interesting, to which all thoughtful men are now looking for the solution of some of the most difficult economic questions of the hour. To you then will appeal, in all its grandeur, this mighty waterfall, the grandest manifestation of physical power upon the face of the globe. As such it is most interesting, most wonderful.

But it is not merely as a natural wonder, not merely as a thing of grandeur and beauty, that you will look upon Niagara. For years the minds of power producers have been turned with longing toward the mighty cataract, and with the rapid advancement lately made in the development of electrical power there seems to have been a corresponding increase of interest in the capacity of the Falls, and from all over this country and all parts of Europe have come within the past three and a half years the suggestions, plans and schemes of all classes of men for the utilization of the power of the Niagara River.

A plan has been formulated which solves the problem successfully. A rapid sketch of it would be understood quite thoroughly if the listener has in mind the topographical features of the river immediately below the Falls, and above them for a mile or two. But let me assist you in grasping the situation: To the eastward of the village for several miles the land is nearly level with the waters of the river, which there move slowly in a broad body; then the rapids succeed, and then the plunge at the Falls 160 feet, and below the chasm 200 feet deep. From the water-level in the chasm below the Falls it is proposed to excavate a tunnel 24 feet in diameter, extending under the village eastwardly at an ascending grade of 1 foot in 100 feet, which tunnel will approach within 400 feet of the river, just east of the present hydraulic canal and at that point will be 125 feet below the surface of the land and the waters of the upper river; thence it will extend eastwardly with a slightly modified grade and parallel with the river, about 1¼ miles, and at its easterly termination will still be 90 feet below the surface, and in diameter 10 feet, the same having been gradually narrowed to that limit in the last 1¼ miles of its length. This tunnel will serve as a tail race, simply to discharge water. Immediately over and above this tunnel will be constructed lateral tunnels, at right angles with the river and the main tunnel, and arranged to discharge into the latter. Over and above the lateral tunnels, and like them, at right angles with the river and the main tunnel and upon the surface of the land, will be excavated surface canals, into which will be diverted the waters of the river. By the side of these canals, wheel-pits can then be excavated and into them turbine wheels placed at a depth of 100 feet below the surface of the land, and arranged to discharge directly into the lateral tunnels below, and thence through the main tunnel or tail-race and into the gorge of the river below the Falls. This system of transverse canals and tunnels would discharge 864,000 cubic feet of water per minute, and furnish 119,000 h. p., and this power is not situated in the midst of inaccessible mountain ranges, but midway between New York and Chicago, on the great trunk lines of railroads, with unsurpassed shipping facilities. The advantages of the situation are apparent at a glance. As enumerated by Thomas Evershed, the originator of the tunnel idea, and summarized by a very high engineering authority in his indorsement of Mr. Evershed's plans, they are: An exhaustless supply of pure water at a practically constant head; solid and durable rock containing all the tunnels, shafts and conduits, and furnishing solid and imperishable foundations for all the structures; and a practically uniform surface, of the proper elevation of the lands necessary for manufacturing structures.*

At Niagara Falls then is nature's great store-house of power for the development of electricity and the successful answer to the question, What can be done in the transmission of power by electricity to a distance? Sir William Thomson said that "Niagara Falls possessed more power than all the coal mines in the world." And a true appreciation of the idea impelled Edison to say that "Niagara is the greatest storage battery in the world." This latter is absolutely truthful, and with the power of the waterfall developed by means of the hydraulic tunnel, a system of powerful dynamos to transform the water-power into electricity, and this transmitted to Buffalo, that city might be supplied with light and power far more cheaply than at present, and the demonstration of the capabilities of electrical power and transmission afforded that would give us something more sure than the world has yet had. The accomplishment of this work would solve the problem of rapid transit in the city of Buffalo.

The secretary then called the roll and read the following communication from Mayor Grant, of New York, to Mr. Weeks:

"Mayor's Office, New York, July 17, 1889.

"Dear Sir: I request your presence at a conference of representative citizens to consider the advisability of holding an international exposition at New York in 1892, and to arrange for the preliminary work if it is deemed advisable. I hope you will be kind enough to attend at my office on Thursday, the 25th of July, at 3:30 o'clock.

"Hugh J. Grant, Mayor."

The President: I greatly regret that I could not attend the meeting, and I hope the association will take appropriate action on a resolution prepared by Mr. Lynch, now in the hands of the Executive Committee, looking toward the co-operation promised Mayor Grant in my answer to the invitation with which he has honored us.

Mr. A. J. De Camp moved that the question be referred to the Executive Committee, to report to the Association in convention at some subsequent session. Carried.

Mr. F. E. Degenhardt: I wish to know if we are to commit ourselves to holding the World's Fair in New York. It strikes me that Chicago is in the field for this fair, and I would like, on behalf of the Mayor of Chicago, Mr. Cregier, to submit for your consideration a proposition from our Mayor looking to that end. I suppose, however, it will be the province of the committee to consider that matter.

The President: As we have no communication from Chicago, it seems to me that Chicago is about to be left on this measure. (Applause.) And let me suggest that there is a Chicago man on the Executive Committee.

Mr. Rhodes, on behalf of the Executive Committee, then made various announcements of entertainments provided for the convention. The convention then adjourned.

AFTERNOON SESSION.

The convention was called to order at 2:45 o'clock by the president.

The President: We will now hear from Chairman Rhodes the report of the Executive Committee:

Mr. Rhodes: Your committee is a large body and, as you know, large bodies move slowly. The committee had a formal meeting at Chicago at the close of the last convention, and the next meeting of that committee was held this morning. A large amount of the business of the association was delegated by that committee to sub-committees, formed of its members, and much of that work has been done and well done. Those sub-committees have only reported this morning, and it is necessary, as has been customary at this convention, that the Executive Committee should wait until later in the proceedings before presenting its formal report: but at the meeting held this morning a matter was brought up which was referred to the association in convention assembled. That was the invitation of the Mayor of the city of New York to this convention to appoint a member who should act in conference with his Honor the Mayor in reference to the proposed Exposition in New York in 1892. I am instructed by the Executive Committee to state that this resolution has been passed by the Executive Committee.

"*Resolved*, That this Executive Committee recommend to the association that the president be authorized and directed to appoint a committee of five members on the pending International Exposition, to be held in 1892, whose chairman shall represent this association on the Conference Committee, called for by his Honor the Mayor of New York City, to aid in making the Exposition a success."

On behalf of the Executive Committee, I move that the resolution be adopted, and that the instructions be carried out.

Mr. Degenhardt: Before accepting the resolution as offered by the Executive Committee, I would like to state that I have in my hand a telegram from Prof. J. P. Barrett, of Chicago, in which he says he is sending a telegram asking the Mayor of Chicago to request that a committee be appointed to co-operate in the efforts towards holding the World's Fair in the city of Chicago. I desire to offer as an amendment to the resolution offered, that it be the sense of this meeting and that the president instruct Mayor Cregier, of Chicago, as well as Mayor Grant, of New York, that we accept their kind offer with thanks, but at this early day, when the entire matter is problematical, it is utterly impracticable to declare ourselves in favor of either city. If we declare at all, let it be Chicago. (Laughter.) Why not Chicago as well as New York? I am not in favor of going on record with my vote in favor of that resolution, except as amended. I move that as an amendment to the resolution.

Mr. Rhodes: Mr. Chairman, in order to postpone or entirely put off a matter which may possibly come up here and take the entire time of this convention this afternoon, as it took the time of the Executive Committee during almost the entire interim of the morning session, I will state how this came up in the committee. The question was raised whether this association should commit itself to a

* A full description of this proposed scheme for the utilization of Niagara appeared in The Electrical World of Aug. 10.

World's Fair in 1892 at New York, in opposition to a World's Fair in 1892 at Chicago, Washington or some other city, and the Executive Committee decided that it could not take ground on that point—that it is not best at this point to commit itself in favor of any city. But on this question we decided that we had before us an invitation from the Mayor of the city of New York to appoint a man—not to forward, understand, not to vote for a World's Fair in New York City—but simply to accept a courteous invitation from the Mayor to appoint a man from our association to meet with him as a Committee of Conference. I hope this matter will not come up for discussion between the cities of New York and Chicago or any other cities, but that it may be treated simply as a courteous invitation to which we are returning a courteous answer.

Mr. W. A. KREIDLER: It seems to me that the report or resolution is not worded so as to express exactly what the committee means. Now, it is a fact that when they went into session, they only had a communication from the Mayor of New York, but it seems to me that we must now take into consideration the Mayor of Chicago, and I think the wording should be changed so that there will be no doubt about its meaning, and about the willingness of the association to co-operate with either mayor of the cities who have addressed an invitation to us.

The PRESIDENT: We have received a telegram from a gentleman connected with the Mayor in an official capacity in Chicago at the eleventh hour. I think the communication from the Mayor of New has been received several weeks, and has been replied to by the president of this association on general principles, assuring him that he might have the co-operation of the interests represented in this association, looking to the holding of a World's Fair, not especially in New York, but anywhere. Now, it seems to me, gentlemen, that the action proposed by our committee does not commit the association to any locality, but is purely general and is eminently in order.

Mr. GEO. M. PHELPS: I do not think that any of the gentlemen who have spoken, if about to answer an invitation to dinner, and he were told that somebody else was about to send him a letter of invitation to another dinner the next morning—I do not think he would pass the question on that account, and my opinion is that we are invited simply to co-operate in organizing a World's Fair in New York. Now we hear that Chicago has some notion of having a World's Fair, too; we have one invitation before us, and are told that we may get another. When the second invitation comes we can answer that.

Mr. ALEX. KEMPT: I understand the position to be this: The gentlemen of Chicago do not desire that this convention, in any shape or manner, shall delegate to New York any preference in the question of the location of the World's Fair. That the electrical fraternity should be represented at the New York effort is proper and fitting, but that this convention should not indicate its preference for New York, Chicago, or any other city. It think if that is the animus of the resolution, it is right that this convention do not make a selection.

Mr. CHARLES A. BROWN (of Chicago, Ill.): I coincide heartily with what Mr. Kempt has said, and what Mr. Kreidler said before, and I further agree with Mr. Kreidler that the resolution read by Chairman Rhodes does not thoroughly express the idea it intends. Mayor Grant has sent an invitation, taking it for granted, just as Mayor Cregier, of Chicago, would take it for granted, that the World's Fair is to be held in Chicago. I, therefore, offer in substitution for that resolution the followng:

"WHEREAS, the location of the World's Fair has not yet been determined upon, and

"WHEREAS, the National Electric Light Association will have several meetings between the present time and the time designated for the said World's Fair,

"*Resolved*, That it is the sense of this body that a vote of thanks be tendered Mayors Grant and Cregier for their recognition of this association; and that the president of this association, in formally expressing to Mayors Grant and Cregier our appreciation of their courtesy, should state that a committee will be appointed at the proper time to represent the electrical interests in the World's Fair, wherever it is to be held, without expressing at present any preference as to the location.

After further discussion by Messrs. Alexander, Kreidler, Brown, De Camp, Dr. Moses and others, Mr. Brown's substitute was lost.

Mr. BROWN: I move you that the resolution offered by Mr. Rhodes be amended by striking out the last clause in that resolution, "In making the Exposition a success."

The amendment offered by Mr. Brown was lost and the original resolution adopted.

The PRESIDENT: We will now hear the report of the committee on the revision of the Constitution and By-laws through its chairman, Dr. Otto A. Moses, of New York.

Dr. MOSES: Mr. President, I have the pleasure, as chairman of the commitee to report upon the revision of the Constitution, to offer the following as the unanimous report of our committee. We had to arrive at the facts and the propositions made in this by means of a very extensive correspondence. We have now on file in the hands of the secretary about 125 answers from the members of this association, to whom were referred questions which were crystallized in this report. From a very large majority of the answers, it became possible for us to offer this, as I might call it, almost unanimous opinion of the members of the National Electric Light Association. For the convenience of the members this report has been printed in such a way as to be opposite to the old Constitution—the present Constitution—that is, on the left hand column; on the right hand column is the proposed Constitution, and I will read Article I.

(Dr. Moses then read the printed Constitution. See page 112.)

Mr. ALEXANDER: Mr. President, as no amendment can be voted upon on the day of its first presentation, I move you, sir, that printed copies of this proposed Constitution be distributed among the members, and that this business be made a special business for Thursday morning at eleven o'clock. Carried.

The PRESIDENT: We will now hear the report of the Committee on Underground Conduits and Conductors, of which Mr. Lynch is chairman.

Mr. LYNCH: On behalf of the committee, I will report that the committee has decided to ask the association for a little longer time to make a report—that it be delayed until the next annual meeting of the association. It is a very short time, only six months since we made our last report, which was rather long, and provoked a great deal of discussion, and we respectfully request that the time be extended until the next annual meeting.

Mr. MORRISON: It is the report of the committee, and it is a question of the adoption of the report of the committee. If you adopt it you only continue the committee. I think they are getting ready to make a report down in New York. (Laughter.)

On motion, duly seconded, the report was adopted and the committee continued.

The following paper was then read by Mr. A. R. Foote on

THE VALUE OF ECONOMIC DATA TO THE ELECTRIC INDUSTRY.

1. All data have an economic basis. True progress depends upon the right use of correct data. Without such use of such data, no problem can be solved, be it industrial, political, social or religious

2. To-day, every proposal for improving the condition of mankind, is based upon data. Read:

1. Economic Aspect of Trusts. By George Gunton. *Political Science Quarterly*, September, 1888.

2. Remedies of Social Evils. By Edward Atkinson. *The Forum*, April, 1889.

3. Legislative Injustice to Railways. By Henry Clews. *North American Review*, March, 1889.

4. Signs of Impending Revolution. By William Barry. *The Forum*, April, 1889.

5. The Relation of Modern Municipalities to Quasi-Public Works. Publications of the American Economic Association, Vol. 2, No. 6, January, 1888.

6. Looking Backward By Edward Bellamy. Houghton, Mifflin & Co., Boston.

7. Robert Elsmere. By Mrs. Humphrey Ward. George Munro, Publisher, New York.

You will find that the direction and strength of all argument is centered on the testimony of evidence obtained from the history of experience. Experience, truthfully recorded and properly understood, is the source of all value in knowledge.

3. The electric industry is based on the experience gained by the utilization of the discoveries of science which preceded it. Its development depends upon a truthful record of its own experiences, and the adaptation of the instruction derived from its own data.

4. To secure the best results for manufacturers, for those who invest in central station plants, and for the users of their services, the data of the industry must be reliable, complete and accessible. It should cover all apparatus, every operating plant, and the price paid for services rendered in every locality. If such a record can be obtained and maintained from year to year, it will be found that the science of data and the command of those agencies by which it may be obtained and utilized, is the most important factor in the development of the industry. As is the prosperity of the users of service, so will be the prosperity of the suppliers of service. As is the prosperity of the buyers of apparatus, so will be the prosperity of the manufacturers of apparatus.

5. The electric industry has been born and carried to its present state of development within one decade. This is evidence of the marvelous skill and honesty of manufacturers, operators and users. The value of this testimony is enormous. It is proof of an average intelligence, a reliability of character and workmanship, far superior to the attainments of any other generation. It furnishes a reliable foundation, on which future development can securely rest. It is the prophecy of the accomplishment of results, such as have never before blessed any age.

The Value of Electrical and Mechanical data to Manufacturers.

6. A long list of electrical and mechanical apparatus is assembled and used as one machine, in the construction and operation of a composite central station. Every manufacturer of each part of this apparatus is vitally interested in knowing the exact truth regarding the performance of his speciality, under the widely varying conditions found in the practical operation of a large number of central stations. It is to his interest that he should claim for his specialty all the advantages it is capable of developing, and no more. The profit on a sale made on the basis of guarantees that cannot be realized, is a disastrous loss.

7. Inventors, designers, and manufacturers use their best efforts to supply a piece of apparatus that shall be the best for its purpose and price. They take careful note of all obtainable experience, and then attempt to take one step in advance by making an improvement. This is the natural law of progress. Their claims for their improvements are honestly made. They are based on tests made in laboratory or shop, where their apparatus is handled by experts under favoring circumstances. The value of improvement depends upon its advantages proven by the tests of practical use when operated by persons representing all degrees of skill, under the widely varying conditions found in a large number of central stations. If it is necessary to take careful note of past experiences, and to keep a careful record of the data of performance during construction, is it not much more necessary to keep a careful record of the data of performance when in practical use? With such a record for a guide, manufacturers and buyers can feel a comforting assurance of certainty in their transactions. This, however, is not the most valuable consideration. Those who accustom themselves to keeping properly systematized central station records, for the purpose of testing the claims of manufacturers of electrical and mechanical apparatus, will become good observers. More often than otherwise, they can suggest some simple change in the apparatus which will enable the manufacturer to fully realize his expectations.

In fact, it may often be found that the manufacturer has claimed too little, instead of too much, for his improvement. If he can secure proper data from the operators of a large number of central stations, he can remodel his claim as well as his apparatus in the light of recorded experience. This will make an enormous gain for him. It will enable him to base his business on a firm foundation not otherwise obtainable. In this there is surely sufficient reason for every manufacturer to encourage, in every way that is open to him, the keeping of systematic records by central station companies having for their object the collation, from experience, of electrical and mechanical data.

The Value of Operating, Maintenance and Administration Data to Central Station Companies.

8. Electrical and mechanical data are but one feature of the record upon which the success of central station companies depends. To complete the circuit, records must be kept of the data pertaining to all details of operation, maintenance and administration.

9. No manager can be equally competent in all departments. Unassisted he cannot observe all the details of the wonderfully complex business assembled in the operation of a composite central station. Upon the keeping of systematic records by his employés depends the ease of his position and the efficiency of his management. The value of a properly devised system of records of the daily operation of a central station can hardly be overestimated.

10. A manager may regard many items in his accounts as reasonable, representing the best that can be done, which, when compared with the accounts of some other manager, whose genius or experience has directed his attention especially to such items, will appear entirely out of the way. No better guide can be found, to where improvement is possible, than such comparisons. The value of the comparison increases in ratio to the number of accounts with which it is made. It is, therefore, to the interest of every central station company to do all in its power to induce every similar company to be represented in an organization through which the desired data can be made available to each.

11. While managers of central station companies can render service of undoubted value to manufacturers by keeping truthful records of electrical and mechanical data, manufacturers can repay managers *in kind* by suggesting improvements in their methods of operating their plants. A manager is isolated. He can observe his own work and methods only. The representatives of manufacturers are everywhere. They observe the work of all managers and are quick to detect the methods of those under whose management their particular specialty produces the best results. Having found this, it is to their interest to communicate the information to every user of such apparatus. Thus, by each manufacturer looking after his own interest, each manager will receive the educational benefit of the experience of all managers pertaining to every detail of the apparatus under his control.

12. By means of the comparisons indicated, covering all electrical and mechanical data and all items of expense and income, any manager will be able to show to his directors how the results of the business he is doing for them compares with the results of all similar undertakings. It will give him the ability to indicate to them unerringly, what changes, if any, must be made in their policy or plant, to enable them to realize the best obtainable results.

13. In furnishing the evidence obtained from the history of his own experience, each manager receives in equal exchange the record of experience of all others. He must be an expert and a wise man who can claim that he will not be a large gainer by such a transaction. Rightly estimated, the gain of each company, from the judicious operation of a proper system for recording and comparing data, will be so enormous, that none, much less the smaller ones, who can least afford to employ highly developed talent, can afford to be without a membership in the organization through which it may be secured.

14. No more pertinent illustration of the value of systematic and organized effort to improve a special feature of the electric industry, can be required than that which is found in the work of the New England Exchange. If the well devised system that has been developed by the workers in that special field can be adopted by the National Electric Light Association as one of its features, that fact alone ought to be sufficient to secure it a membership from every central station company in this country.

The Value of Data to the Users of Electric Service.

15. The value of economic data to the electric industry cannot be completely stated without considering the interests of the users of electric service.

16. From an electrical or mechanical point of view, the value of all apparatus finds expression in light or power. From an industrial point of view its value is expressed in the advantages it brings to the users of its service. These advantages are limited by what it enables them to do and what it costs to do it.

17. The advantages of electric service are not wholly under the control of manufacturers of apparatus, nor of the owners of central stations. Their development depends largely on the public policy of the community in which the service is rendered.

If that policy places unnecessary restrictions on the business of the central station company, imposes on it methods of construction having no foundation in engineering requirements, nor in true considerations for the public safety or convenience; or, if it holds over the company an eternal menace by being willing to grant a franchise to a raiding enterprise, under the mistaken idea that prices can be permanently cheapened by competition, it will pay a righteous tax for its mistakes, in the price of the service it uses.

A comparison of the results of such a policy, with that of a community that intelligently permits construction in accordance with the best engineering requirements and true consideration for the public safety and convenience; that sets itself as firmly against an ordinance permitting competition as it would a declaration of war, cannot fail to educate all users of service to a correct understanding of true economic conditions.

18. In the competition between cities, states and nations, the utilization of the discoveries of science in accord with the requirements of natural economic law, is a more potent factor in securing industrial supremacy than the possession of natural advantages. The day has come when intelligence is master of physical forces. When these truths are properly understood the users of electric service will demand and enact economic legislation that will secure the interests of the manufacturers of apparatus, the suppliers and the users of electric service, on terms that will enable each to realize the highest economic advantages that can be derived from the perfect development of the electric industry. The advantages of a public opinion so educated should not fail to cause all who can to unite in securing the data on which it must be based.

The Value of Data to Investors in Electric Stocks and Bonds.

19. The proper construction, equipment and operation of a composite central station, designed to supply a community with the foundational necessities for industrial prosperity, and domestic comfort and refinement—*heat, power and light*—is an undertaking beyond the reach of ordinary private capital. It is a public improvement, the capital for which must be secured by the sale of the stocks and bonds of the company organized to carry on the enterprise.

20. A central station company must be organized under the state law. It must operate under a municipal franchise. From its birth, through all its existence, it must be subject to the regulation and control of state and municipal legislation. This fact should secure for its stocks and bonds a financial standing equal to that of the best securities in the world. That they are not so held is evidence that there is a lack of data regarding them, and an unwise or unsettled condition of public policy regarding the tenure of their occupation of the field of their operations.

21. In my opinion, the exercise of state authority for the regulation and control of companies organized under state laws to operate under municipal franchises, should be so used as to render their securities as safe and profitable an investment as are the securities of national banks. Both are creations of legislative enactment. Both supply fundamental wants of industrial life. A calamity that would render users of *heat, power and light* incapable of paying their bills for service rendered, would render them incapable of paying their bank obligations. Organized to supply necessities of civilized life, based upon the prosperity of the communities in which they are located, guaranteed by the ability of users to pay for a service that secures them an industrial advantage, there is no economic reason why the securities of central station companies should not be a favorite investment for all who desire *permanency, safety and profit.*

22. Large investors require the greatest certainty and accept the smallest return for the use of their capital. All data and all legislation that tends to secure safety and permanency of investment, will tend to make capital abundant and cheap for central station companies, and thus enable them to reduce the cost of their service to its users. A community can serve its interests in no better way than to exercise its power of regulation and control, to secure the necessary data to guide intelligently, investments in public improvements and its own legislative action.

23. The securities that to-day bring investors the smallest returns are those of the public debt. They represent the destructions of war. This fact does not prove that the destructions of war are of greater service to humanity than the constructions of peace. It proves that a nation, as well as an individual, will give all it has for the preservation of its life. That it may always command "the sinews of war," it cannot allow its credit to become impaired. For this reason, the natural law of self-preservation has quickened man's intellect to devise laws for public finance, designed to give the greatest possible security to investments in government bonds. Next to the duty of preserving life, is the duty to make life worth living. Government will confer its greatest benefit on society when it renders investments in those enterprises which daily supply the necessities, comforts and refinements of life the best securities in the market. This done, capital, the sinews of peace as well as of war, will flow to such enterprises in abundant supply, and humanity will realize a condition of civilization such as the world has never yet enjoyed.

The Value of Data Collected by Government Authority.

24. Every ten years, under direction of the national government, a census is taken. The history of the development of the national census among all peoples is the history of their appreciation of the value of data. From the mere enumeration of men able to bear arms, census taking has broadened until it includes all data having a social or industrial interest.

25. The census of 1880 has no section for the industry of generating and distributing from central stations electric service for the uses of light and power. The census of 1890 should have such a section. If the data for it are properly collated and arranged it will make a marvelous exhibition of the birth and growth of an industry in the short space of one decade. The annals of civilization may be searched in vain for a parallel to it.

26. The data so acquired and published by authority of the national government, will give an impetus to all electric central station service, that will cause the record of the decade from 1890 to 1900, to be one of the transformations of methods of generating and distributing the means of supplying cities and towns with *heat, power and light.*

27. In 1900, the electric light will be the light of the present, the operating of street cars by horses will be unknown, and physical labor for man or woman in all industrial and domestic occupations will be reduced to a lower minimum than has ever yet been realized.

The True Basis for the Work and Influence of the National Electric Light Association.

28. None of the results indicated can be obtained, desirable as they may be, unless they are the results of system and organization.

29. That records may be kept regarding pertinent points only, and with the least work or cost; that the data may be so tabulated that it can be readily understood and compared—a uniform system of records and accounts must be devised, covering all points of interest. To devise such a system and institute proper comparisons for the use and benefit of all central station companies, is the direct and most important work of this association. By doing this, it will furnish a reason for all central station companies to be represented in its membership. Such a membership will give to its deliberations and actions an influence that will have all the binding force of law in some directions, and in other particulars it will so direct public opinion that laws will be shaped in accordance with its views.

30. It will establish the electrical and mechanical value of all apparatus. It will develop the operation of central stations into the best organized and most reliable service in the country. It will secure the highest possible degree of economy, and the most reliable returns for invested capital that can be found in any industry. In doing this, it will be a large contributor to the material prosperity of the people.

31. The work and influence of the National Electric Light Association must begin in data, they must be sustained by data, they must have for their objective point the securing of data.

32. Data are recorded truth.

33. "Commend to the keeping of the Truth whatever the Truth hath given thee, and thou shalt lose nothing."—St. Augustine.

Mr. FOOTE: Mr. President, to give practical effect to my paper, I respectfully submit the following for the action of the association:

WHEREAS, It is desirable that this association shall collect for the use and benefit of its members complete and accurate data regarding all important details involved in installing, operating, maintaining and administering the plants and business of central station companies,

Resolved, That a committee of five be appointed by the president to report at the next convention of the association forms and a system of records and accounts to be kept by central station companies, a system for reporting the same to the association and for comparing and publishing the data so secured for the use and benefit of the members of the association.

The motion was seconded by Mr. Brown.

Mr. MORRISON: Mr. Foote is engaged in a work that almost every one has neglected, and yet without which work we would probably never be able to conduct the electric business successfully. It is the true channel through which information should come. If you can once get down to the point where men will come into the National Electric Light Association, and state in plain terms their plans and their methods and the result accomplished, then you will have gotten to the point where the original idea of the National Electric Light Association can be carried out. Mr. Foote is on that track. I believe I am doing him scant justice when I say that he has spent more time and more money in the service of the National Electric Light Association, during the past twelve months, than any man in it, from its president down to the last man on the board. (Applause.) I think that such work should be appreciated. I believe it will be appreciated, and I think in the end appreciated in a substantial manner to Mr. Foote.

The president put the resolution and declared it carried.

Mr. ROBERT L. MORRIS, of Nashville: I believe this is the second meeting of this convention that I have attended, and as a member of the Executive Committee I can say that I am glad to come and get the new kinks and points from others, and get practical benefit from them. We have had a representative, I believe, at every meeting, and I have attended two or three of them myself. But it has been an unsatisfactory thing to me. I have come to these meetings, and my manager and my superintendent have come. We come here and go away not feeling exactly that we have got what we came for. What we wanted was new points, practical points. We have come here and heard a great many theories upon electric light matters, and all that sort of thing, but that was not what we wanted. We had a committee here at one time to consider which was the best wire. I tried at one time to get a report out of that committee, but I could not do so, and nothing practical was done. Now, Mr. Foote's paper seems to me striking out in the right direction—to get at the practical, to get at things that will benefit local electric light men. That is what I am here for, representing that sort of an interest. While I believe that it is hardly practicable to get the data such as that resolution calls for, and while I believe that very few companies are going to disclose their private business, show us exactly what they are doing, and all that sort of thing, yet perhaps they will be willing to tell us something about the operation of their machinery, how it is produced, what is the effect, and such as that. If I am asked what is the best lamp; I don't hesitate to say. But I think that perhaps we can safely risk this convention, composed of members of different electric light companies, to express itself in behalf of a measure so evidently for the benefit of us all.

Mr. DE CAMP: Mr. Chairman, in regard to Mr. Foote's paper, I think he has made some suggestions which will bear looking into a good deal more closely. Like Mr. Morris, I attended the first meeting of this association, or the one at Baltimore, for the very reason that he states. At that time there was considerable money invested in the electric light business, and more money being invested, and the main object seemed to be then to find out how to properly invest the money that was being called into this electric light business. The methods of the association then were crude, and, if I recollect right, did not take the form of reading papers. Every member got up and said what he felt like saying, and generally spoke pretty well to the point; consequently there was a great deal more talking done than there has been in the late meetings. The result was that I believe that the second $100,000 invested in Philadelphia was invested better than the first. The first was invested on a great deal of guess work; the second was invested on some knowledge, partly gained from the experience of investing the first ourselves and what we later had the opportunity of observing what others had invested. Now, we have had a great deal of money invested, not that there might not be more; but another thing comes in, and that is, to make the most out of what we have got invested. I think that one of the most beneficial things growing out of this association is to do away with the prejudice existing among the different systems. At the first meetings an advocate of the Brush system would not dare open his mouth in favor of that system to a man representing another system, and vice versa. That is now done away with. No one hesitates about expressing himself now: in fact, there is so much information all around, it is pretty risky for a man not to tell the truth. But still, at the same time, there is a sealed book existing among the electric light people, and the resolution that has been offered opens it. I know of companies that are deceiving themselves both ways. This I know of my positive knowledge. Some are deceiving themselves with the idea that they are making more money than they really are; they think they are making money when they are really not making a dollar. There are others that think they are making nothing when they are doing very handsomely. It is my misfortune to be interested in companies of both characters; it is a very unfortunate position to be in. I have had to stand up and make statements and rely upon my word being accepted, upon matters in which my statement was the only evidence I had to offer of their truth; I mean abstruse subjects, and matters on which they were entirely skeptical. They had only my say-so, and if they were skeptical on the first statements I made, they were skeptical on the second. But if we had matters in this association in such shape as contemplated by this resolution, every manager of a company would feel very much stronger; he could present his business to his board of direction with a good deal more force. I appreciate that it is a very difficult subject to deal with, but still, at the same time, I do think that that can be got in such shape that a report can be made without in any manner or form revealing the private affairs of any particular company. I think that is entirely possible, but the greatest difficulty is to get the companies to appreciate it, because it is going to involve the complete changing of the systems of some of the companies. It is true that a great many do not have any particular system. I have known cases of that kind; but still they think they have, and they are going to be required to change them very radically, and that is going to be the difficulty in carrying that resolution into effect. But there is no doubt that there is a great deal of information that is needed among the electric companies. This is going a good way, to say that people do not understand their own business, but there are some things about my own business that in a self-satisfied way I think I understand; but at the same time, down at the bottom of it, I am very doubtful myself.

Mr. COGGESHALL: As it was stated that this paper would be on economic data, I was in hopes that the gentleman had discovered a method by which he could show me how to run an electric light plant, and make money out of it. Of course, the plant I have (as operated by the old company) was put up in a way that it was impossible to make any money, and we are now erecting a new station; but I do not see any difficulty at all in getting information, without detriment to any company at all; data, for instance, in relation to the coal, the kind of wire used, the durability of the circuit, and various other matters that would be profitable to every member of this association. I belong to the gas fraternity, and I have always attended every meeting, and when I found any one else doing any better than I was, it only set me to work to come up to it. That has been my point, and I am satisfied that there can be money made in the electric light business. These statistics, as far as we have got any in the State of Massachusetts last year, from 75 or 80 companies, showed that there were only five that carried a debit to profit and loss account, so that the whole thing depends upon the commercial value of running an electric plant, and it is the data that we want to be guided by regarding their operation.

Mr. WHIPPLE made a few pertinent remarks on the value and importance of such data.

Mr. DE CAMP: So many matters of judgment enter into the question of costs, you cannot tell what a thing costs without going into the whole details. To illustrate, it is not necessary to say what the lights in this plant or in that plant cost, or what they are selling for. That is private property, which I do not feel like spreading before this convention; but a man comes to me to-day and says, "My lights actually cost me 15 cents a light." Another man says, "My coal only costs me so much." Now, both of those gentlemen may be right in their conclusions. You cannot draw any comparison between these two men, because you do not know how they arrive at the figures. Now, if you will formulate a system of keeping those accounts uniform in all the companies, you will have them arrive at conclusions by precisely the same method.

Mr. MORRIS: I am in favor of that committee being appointed, and I believe it can do some good. They can formulate some of the questions that may be of value; for instance, the gentleman here at my right has asked me a number of questions about my station. I know they could be put in the shape of questions and sent over the land, and their answers would be satisfactory to me; and I am willing to risk the intelligence of that committee in formulating the questions for central stations to answer.

The PRESIDENT: If there is no further discussion, the topic will now be passed. We will now hear from Mr. M. D. Law, of Philadelphia.

Mr. M. D. Law then read the following paper on

THE PERFECT ARC CENTRAL STATION.

It has usually been more the rule than the exception that electric light central stations have been located in almost any place that could be had; some old shell of a building would be used, that would have nothing to recommend it except that it was cheap.

In fact, the first station for central lighting purposes was started in San Francisco in a blacksmith's shop, using an old, worn-out, portable engine and boiler. The force consisted of one man, who was superintendent, dynamo man, engineer, fireman, trimmer, inspector and lineman; but the price received for the lights would gladden the hearts of the electric light companies of to-day; they were ten dollars per week per lamp, and burned from dusk to midnight, except Sundays. And when I look back to that time of running arc lamps on one wire, with ground return, I am amazed that there were so few troubles in the shape of grounds and fires. Not only was a ground return used, but inside wiring was thought good enough when put up without any insulation, but fastened with wire staples.

There are a great many places even now, where bare wires are stapled fast, showing the absolute need of good, competent, fearless inspectors, who will examine every inch of wire in a building, and not be afraid to condemn it if it does not come up to the requirements of safety. Then, again, all inside wiring should be inspected at least once a month.

An electric lighting station should be located as near the centre of the territory to be lighted as possible, but if sufficient ground cannot be obtained at a reasonable cost, then it is better to go a little to one side rather than be crowded for room; for when an electric lighting station is cramped for room it cannot be handled with economy, as one of the greatest successes of central station work is not only in the simple running of the machinery well, but, when troubles occur in the shape of breakdowns, (which are liable to happen in the best regulated station), there should be sufficient room to move the machinery, without taking too much time. In such a case time is money, for the amount of money allowed in rebates is only a small fraction of the loss, as the reputation of never having the lights out is worth much more than their mere money value. For, electric lights are not a success until they can be placed in business houses and halls, having no other method of illumination, without danger of their being suddenly left in darkness; rather have the machinery and lines in such shape that the lights can be depended upon at all times. This may take a little more money for the construction of the plant, but it will be more than made up in the commercial value of the lights.

An electric lighting station should be built of brick or stone, in a neat, substantial manner, not more than two stories high, and be as nearly fire-proof as possible. One of the important factors of such a station is good ventilation, it being necessary to keep engines, shafting and dynamos as cool as possible. This not only adds to to their life, but their over-heating is a great element of danger to the success of the lights.

Boiler-Rooms and Boilers.

The boiler room should be located on the groond floor, with plenty of ventilation, making the fire room cool and comfortable. Everything being in full view and easy of access, can be kept clean and in order.

In constructing an electric light station, the dynamos and engines are generally placed first, and what room is left the boilers are thrown into, without much regard to their economical handling. It is better to have a comfortable fire-room, as the firemen can then remain by the boilers, doing justice to their work. By having boilers in cellars, cramped, or poorly lighted and ventilated places it makes the men careless, and also detracts from the life of the boilers by corrosion and improper care.

It is found that two thirds of the steam which is generated in a tubular boiler is made on the shell, and not in the boiler tubes, as supposed. In taking the heating surface of boiler tubes we should only take one half of the circumference, as the flame only impinges on the upper half of the tubes. With proper setting, flame can be carried the full length of a thirty-foot boiler, with ordinary natural draught, using secondary combustion. Automatic dampers should never be used; by their use it is impossible to get proper combustion, as they are either open or closed, besides having the tendency to make firemen careless. An ordinary fireman with hand dampers, can fire with not over two pounds variation of steam in a run of twelve hours. When the boilers are working to within three to five pounds of their utmost capacity, the hand dampers are kept partly open, and as the steam varies the damper is changed to suit, therefore always allowing of proper combustion.

For a one-thousand-light station there should be twelve single tubular boilers, 48 inches in diameter and 20 feet long, with twenty-two 5-inch tubes, the shell to be made of three-eighth inch steel or iron, having a tensile strength of 55,000 pounds and 25 per cent. ductility in 8 inches.

Double riveted longitudinal seams and first-class workmanship will stand a safe working pressure of 130 pounds per square inch, which will give 1,325 horse-power. With the Corliss type of engine carrying 110 pounds per square inch, there would therefore be three boilers, which could be held in reserve, that being none too many for safety, and the other nine boilers can be worked very easily, as rapid combustion is the most economical.

Engines.

Electric lighting is one of the hardest kinds of work for a steam engine, the continuous running and the work being thrown on and off instantaneously, causing immense strains.

They should be twin engines, connected at right angles, by which we have steadier power than with single engines, because we have the impulse of the steam at every quarter of a revolution. They should be built specially and have a larger amount of iron in all their parts than is used in an ordinary commercial engine, so that in times of trouble they can be forced for a short time beyond their ordinary load.

For a one-thousand light station there should be two 23 × 48-inch twin engines, running at a speed of from seventy to eighty revolutions. With this number and size of engines there will be a reserve of one engine, as the three engines will easily carry the load of one thousand lights with economy.

It is a settled fact that the Corliss type of non-condensing engines, properly constructed and handled, are the most economical, using less than two and one-half pounds of coal per horse-power-hour, working at 110 to 115 pounds of steam per square inch. High rotative speed is not necessary for electric lighting, but it does require a steady and uniform speed. An engine running forty revolutions per minute, provided the speed is regular, will make as good lights as one running three hundred revolutions.

It has been practically demonstrated in a great number of plants, which have used the small, high rotative speed engines, that such is the fact, the low speed using less coal, oil and attention, while the cost for repairs is very much less, as well as loss of steam from radiation, clearances, etc., than high-speed engines. On a pair of Corliss engines 23 × 48 inches, at 75 revolutions per minute, running day and night for nearly seven years, the actual cost for repairs was but $25, and during that time they were shut down but once on account of breakage, and then only ten minutes to disconnect one engine, the other being run with the load of both at increased steam pressure.

Shafting.

The friction of a high rotative speed engine and a 60-light dynamo is 6 indicated horse-power, while the friction of one pair of engines, shafting, 22 empty dynamos, 11 idlers, and 22 Hill clutch pulleys, 5 feet in diameter and 12-inch face, is but 72 indicated horse-power, both running up to speed. The only argument against large engines is that in case of breakage it stops the whole plant, whereas in a series of small engines, connected direct, it will stop but one dynamo.

In all cases shafting should be made of hammered iron, and for a 1,000-light station the main line should be 75 feet long and 6 inches in diameter, and about 55 feet of counter shaft, commencing at 5 inches diameter and reducing one-half an inch for every two machines, to be located on the ground floor, with pedestals as low as possible and bearings of cast iron, not less than four to one. The main bearings ought to be of phosphor bronze, and the shafting run not less than 300 revolutions per minute. The expense of oil on such a shaft, with proper appliances, will not be over $3 per year.

The driven pulleys from the engines should be on the two ends of the main line of the shaft, with a clutch cut-off between one engine and the first dynamo pulley, one between the last dynamo and counter pulley, and one between the counter pulley and the other engine, with a clutch on the counter pulley. This will give perfect control of the main shaft and counter shaft, and can either run one or both engines, as the load may require.

Dynamos.

The dynamo room should be directly over the shaft lines, so as to use angle belts. The light should be good, and the ventilation perfect. The roof should be supported without posts and be of sufficient height so that the dynamos or armatures can be hoisted and carried over the ones that are running. Insufficient room overhead is a great drawback to the successful handling of electric light machinery.

The dynamos should be small and mounted on cast-iron beds, left entirely open to allow perfect cleaning, as the life of dynamos depends very much upon their cleanliness. They should be placed in rows, with sufficient space between them to allow easy access to all of their parts, as well as ample room, that they may be moved from one part of the room to another without disturbing those that are running.

If the roof cannot be made sufficiently strong to support the combined weight of dynamo and armature on a track, then a good substitute is a frame supported on large casters, with a track over the top, having on it a chain-geared trolley and a chain hoist. This will allow of the rapid lifting of the dynamo, its moving to some other place, rolling the hoisting frame to that place, and putting the dynamo in proper position for running. With this arrangement a 3-ton machine may be moved and put in running order in 30 minutes, requiring but four men; with a little longer time two men will do the same work.

A cupola should be provided, not smaller than ten by thirty feet, and ten feet high, with window ventilators extending the full length of the two sides, and so arranged as to be under the full control of the machine man. With such a cupola, one is enabled to put the lines in good shape, as well as to carry off a large amount of heat. The wires should run to the switch board from binding posts placed through the centre of the cupola, and all crossing of lines should be made at this point.

Switch Board.

The switch board should be placed in the middle of one side of the dynamo room, and four feet from the wall, and should be at least 25 feet long, which will give room for 50 circuits. As it is impossible to keep all circuits built up to the full capacity of the machine, it is well to have a number of small circuits to couple in, in order to build up to the full machine capacity, as all dynamos work more economically with a full load.

The line wires should come into spring jacks, which are arranged in two rows, with one side of the circuit on top and the other below, with eight inches of space between them, so that there is no possible danger of a person being liable to touch or short circuit two of them. Before attaching to the spring jack, one side of the circuit should pass through an indicator for showing the direction of the current. The wires from the dynamos should be run beneath the floor, coming up on the back of the switch board, and enter binding posts, to which a flexible cable should be attached, having a wooden-handled plug for entering the spring jack; these cables should be of sufficient length to reach either end of the switch board. The spring jacks and binding posts of the machine cable should be so arranged that a connection cable can be hooked on for the purpose of moving the machine cable from one circuit to another, to cut out or cut in circuits, without extinguishing the lights already burning. The positive wire coming from the dynamo should pass through an ammeter before entering its binding posts.

A good arrangement for making ground tests and locating grounds while lights are burning is a set of thirty 92-volt incandescent lamps in series, so arranged with a circular switch that any number may be short-circuited at will. With one side of this lamp circuit connected to ground and the other side connected to the line to be tested, a ground on the line will show by one or more of the lamps burning.

I find that with the lamp burning, on, say, the positive side of the test circuit, with an electromotive force of 92 volts, the ground may be looked for between the second and third arc lamp on that side of the circuit; in fact, each 92-volt lamp will represent two arc lamps or their equivalent in line wire resistance. This is a simple and handy method of locating grounds, especially if the positive and negative side of the circuit are much separated, for it starts one out on the right end of the wire, which is rarely the case, without some reliable method of testing. When two grounds occur at night, cutting out a number of lights, it is necessary to be able to start out with some knowledge of its locality, especially if such a circuit is from 12 to 15 miles long, and starting out from one point of the compass and returning by another.

If there is an indication that the full number of arc lamps are not burning on a circuit, by attaching one side of this test to the positive and the other to the negative spring jack of the circuit in doubt, it will show within one or two lamps of the number that are burning.

Ammeters, lightning arresters, indicators and all connections should be placed on the switch board.

Lines.

Lines in all cases should be supported on glass or porcelain throughout their whole length, and should never enter a building without passing through hard rubber tubing with water drips on the outside. In all cases, inside wires should be run on glass or porcelain insulators; moldings or cleats should never be used for arc light wires, and in no case should they be put under floors or out of sight.

All arc lamps should be hung on porcelain insulators, and in the case of outside lamps all iron should be galvanized to prevent the rust from collecting on the insulators, which gives a first-class ground, if the fixture connects to tin gutters or iron work.

All lines should be tested for grounds at least three times during the day, and once every hour while the lights are burning; as soon as a ground occurs it should be immediately found and cleared.

Store Room.

The store room should be of good size and provided with cupboards, drawers and shelves, that a full line of all supplies can be kept on hand and issued only on requisitions from foreman of construction gang. When a job is completed a return should be made of the material returned and the charge entered in the proper books.

A carbon book should be kept in which each trimmer signs a receipt for the carbons issued each day, as the trimmer reports each day the number of carbons used on his route. The stumps returned must accord with the report at the end of the week; he must account for the number of carbons on hand or pay for them. The trimmer will only pay for one lot of lost or broken carbons, as he finds it easier to take care of carbons than to buy them.

Shop.

The shop should be of good size and provided with at least one 12-inch lathe, drill press and buffing wheel, with sufficient small tools for all kinds of repairing and the manufacturing of switches, fixtures, insulators, and all the thousand-and-one articles that come up for use in such a station.

The test rack should be located in the shop and be large enough to hold at least four lamps, each lamp to be provided with an adjustable lens for focusing the arc of a lamp on a screen; this affords a good opportunity of closely watching the arc without injury to the eyes, and has a capacity of from seven to ten lamps per day.

Mr. MORRISON: Will you please read again, Mr. Law, that paragraph relating to the running of the engines?

Mr. LAW then read the paragraph stating that two Corliss engines in his station have been run for seven years at a cost of only $25 for repairs, and that then the only time lost was ten minutes for disconnecting from one engine to the other.

Mr. MORRISON: Is it possible that you ran your engine for seven years?

Mr. LAW: Yes, sir; for seven years. They were stopped about an hour each morning and on Sundays.

Mr. MORRISON: It is a very remarkable performance. Have you been familiar with any other engines than the Corliss?

Mr. LAW: Yes, with the Porter-Allen and the Buckeye, about 100 horse-power.

Mr. MORRISON: If these statistics are true, they are very remarkable; if they are not true they are very misleading. Gentlemen who have had experience in this matter, it strikes me, should ask questions about it to see if it is an error. The performance of these engines is so remarkable; I have never heard of such a thing. Were they run by one engineer all of that time?

Mr. LAW: Yes; the same chief engineer had charge during the whole seven years.

Mr. MORRISON: The description Mr. Law has given of an ideal station is a description of his own station. (Laughter.) It is a very fine station and it is an infinite credit to him, but I cannot imagine how an engine, such as the one in the Philadelphia station, could run for seven years without stopping--the paper says run continuously. They never stopped but once, and that was on account of a break-down.

Mr. SMITH: I think this is one case Mr. Foote's paper would cover. Mr. Law states that the engines have only cost $25 for repairs. I would like to ask if the engineers, when the engines were shut down, have not done a good deal of fixing up, keying up, putting in packing, etc., which has not been charged up. On the other hand, I understand Mr. Law has a first-class mechanical engineer who is a sort of consulting engineer, and whose advice or time ought to be charged to these engines, because I am very well satisfied that engines of that type cannot be kept up to such a remarkably good record—as I know these engines have—without care of any kind, which, while it seems to be more expensive, is often the cheapest in the long run. The $25 that he counts for repairs, I presume, are outside repairs, for a new set of brasses or something of that kind. We had one, 24 × 28, that cost us $1,000 for eleven months' run.

Mr. MORRISON: We have some Corliss engines, and while they are good, their result is nothing like that. We have quite a large lot of Buckeyes which give excellent satisfaction. We have also Ball engines, tip top engines, giving the very best of satisfaction, and costing very little for repairs. But they have stopped several times in the last six or seven years. The Corliss engines are the worst of the lot.

Mr. LEONARD, of Minneapolis: I would like to state in behalf of the Corliss engines, taht we have been using one for nearly five years, and one of those engines which we have recently taken down to make room for a larger one, ran four weeks continuously, day and night, twenty-four hours in a day, without shutting down, except for general repairs and tightening up, some little matter, but nothing the matter with the engines. It ran continuously for four weeks, and those engines, outside of packing, which everybody knows will wear out more or less, have not cost more than $25 for repairs.

Mr. DE CAMP: I think Mr. Morrison is right in saying we want facts. Now, facts are sometimes deceptive, unless we understand thoroughly all the conditions which surround the facts. It is true that the pair of Corliss engines referred to by Mr. Law did run seven years. They ran continuously—we had nothing else to run—for an average of 22 hours a day the year around, with the exception of Sundays, when they shut down about the usual time in the morning and started up in the afternoon. They rested eight hours on Sunday. What Mr. Law means in his statement is this: Not that we did not incur the expense of having them well taken care of, nor that they were not subject to a certain amount of wear and tear. When he says $25 he is outside of the mark. That $25 grew out of the breaking of a dash-pot rod; but these are extraordinary conditions. They were put in there as 24 × 28; the cylinders are bored out at 23. Every part of the engine was made from a pattern one size larger; consequently we are running a Corliss engine 23 × 48, built on 26-inch patterns. The foundations of those engines cost, I think, about $2,600 or $2,700. Now, I say this. I approved the specifications for that engine. I approved of the specifications for the foundations against the judgment of the builder, but did it on this basis. The chief engineer says he wants to do this—that is what he expects. For instance, the specifications were made for the foundations; one of the requirements was that they were to be of a certain size, they should be hard brick, laid in pure cement. The lowest bid was, I think, some $2,600. It was from a man who had very large experience in building engine foundations, one of the best men we had in Philadelphia. He came in and made his estimate. He started in and laid two or three courses of brick. The engineer said, "Stop; the specifications call for pure cement." "Well, this is pure cement—a certain portion of cement and a certain portion of sand." "But I want pure cement." "Do you want absolutely pure cement? I understood this thing the way we generally term pure cement, but what you mean is that every brick shall be dipped in absolutely pure cement." I said, "I do not think it is just the proper thing to take advantage of some individual construction of the engineer," and I called him in and said, "Now, do you mean exactly what this says?". "Yes;" in his judgment it was necessary, and he said, "We want those foundations that way, and want that engine to stand and don't want any after-claps about it." I said, "Then we will have to have it." That contractor told me he never built such a foundation like that before in his life. Now, in point of fact, there has never been a movement in that engine.

Another thing, we have followed the rule of using first-class oil; I think we are paying 90 cents for cylinder oil and 40 or 45 cents for machine oil for the bearings. The time we shut down it was due to a hot crank requiring adjustment. That part of the expense was not charged for. It was done by our men—by men that we were paying, whether we had them at work or not. It is only now that the chief engineer makes a suggestion to me that if he could get a chance to shut down he would like to have them bored out; not that he thinks it is an absolute necessity, but he thinks the time is coming when we will have to do it.

But the success of these engines is due to the fact that they were well built in the first place, well bedded, and that they have had good care, for which we have had to pay.

Mr. SMITH: Then you do not consider that it is due to the fact of their being Corliss engines at all?

Mr. DE CAMP: Well, I am a Corliss engine man. I do believe this: that you want a Corliss engine in the hands of a Corliss man. That is certain, and they have said to me: "You must have a man to run a Corliss engine who understands a Corliss engine, who is in love with a Corliss engine." Now as to the cost, I don't mention the fact that we painted the engine. (Laughter.) To come back to the Buckeye engine; we have two Buckeye engines, 18 × 36. In the first place, the Buckeye engines that we ran for five years were run on an entirely different principle from what we were in the habit of running those engines. They were run just as long as they would run. The consequence was, that when the time came, they made a bad break. When I take a given number of dynamos and run them on one type of engine, and they consume a certain amount of coal, if I shift them on to another type of engine, and everything else being perfectly equal they use an excessive amount of coal; the one using the smallest amount of coal, I call the most economical engine. We ran Porter-Allen's one season, and then put in Corliss engines. It was necessary to run the Porter-Allen's hard, and we had the old type of Brush machine, forty lights. They did their work all right at 285 revolutions, 100 pounds of steam, 8 × 16. Now, Brush improved the dynamo to a 60-light machine. That was more of a load than the engine was equal to. We could never run more than fifty lights successfully, and did that by speeding the machine to 300, and carrying the same amount of pressure. We found out that there was economy in the Corliss engine, and that was the reason for dispensing with the Porter-Allen and substituting a Corliss, or some other larger engine.

The PRESIDENT: I announce the following committee on the World's Fair: Dr. Otto A. Moses, of New York, Chairman; E. T. Lynch, Jr., C. J. Field, Fred Gilbert and J. F. Morrison, Assistants. As a Committee on Electrical Statistics, the Chair would announce Mr. A. R. Foote, of Cincinnati, Chairman; Assistants, Mr. A. J. DeCamp, of Philadelphia; S. A. Duncan, of Pittsburgh; E. F. Peck, of Brooklyn; S. S. Leonard, Minneapolis.

On motion, duly seconded, the Convention adjourned until 10 o'clock Wednesday morning.

WEDNESDAY, FORENOON SESSION.

The president called the meeting to order, and the secretary and treasurer presented the following report:

REPORT OF TREASURER AND SECRETARY.

NEW YORK, July 31, 1889.

RECEIPTS AND DISBURSEMENTS.

Cash balance from last report	$3,003.82
Dues received from 76 members	1,520.00
Sale of printed matter	2.00
Received from Ex-Treasurer W. H. Harding	299.73
Total receipts since last report	4,825.55
Expenditures as per accompanying vouchers approved by the executive committee	3,728.62
Balance, cash on hand	1,099.93
	$4,825.55

The present indebtedness is $259.60, which is part of the funds advanced to the association by Ex-President S. A. Duncan.

The expenditures since the last report may be classified as follows:

Bills incurred previous to the Chicago convention	$1,483.82
Salary of secretary and treasurer, six months	999.96
Clerk hire, month of February	40.00
Postage	127.96
Stationery and printing (not including the official proceedings)	234.03
Printing the official proceedings	334.26
Official stenographic report of Chicago convention	161.25
Rent of office	157.50
Advertising in electrical journals	55.00
Expenditures not specified above	131.84
	$3,728.62

It will be noted from the Official Record of the New York Convention that the account of the ex-treasurer called for a cash balance of $1,935.23, whereas the present treasurer has received only $299.73.

The treasurer would here state that he has received from the executive committee vouchers covering the difference

between the above amounts. He has also received from ex-Treasurer Harding $34.25, which did not belong to the general funds of the association; but was donated by members to the Committee on Patent Legislation. This sum has been turned over to the chairman of that committee.

MEMBERSHIP, INCOME AND EXPENSES.

The number of members in good and regular standing on Feb. 19, 1889, as per official report accepted at the Chicago Convention, was 175; new members since that date, 76, making a total membership at present of 251.

The membership of the association has increased during the last year 55 per cent.

It has increased in the last six months 30 per cent.

The annual income of the association is at present $5,020.

Its running expenses for the last six months were $2,241.80.

THE SECRETARY: This is the report up to the first of that month. Since that time the treasurer has taken in several hundred dollars. I have here the vouchers covering the expenses. I have a certificate of deposit of the balance of $1,950.

Mr. P. H. Alexander then presented the following REPORT ON HARMONIZING ELECTRICAL AND INSURANCE INTERESTS.

After reading a number of letters from various insurance interests, Mr. Alexander's report said:

You will readily see that with proper work on your part, such as the examining and licensing of men employed to make the electrical installations, encouraging thorough inspection of work done, etc., harmonious action can be brought about.

The 876 circulars issued to electric light companies—circulars that were issued entirely in their interest, the publication of the result of the answers could only have the effect of putting money into their pockets—were, we are sorry to say, answered by but 241 companies; of these 241 companies 172 were insured, 69 were not insured. In many cases they state (where it is not stated the reasons are probably the same) that they carry no insurance because the rate of insurance was either too exorbitant or they could not get any insurance at all; and here we may say in extenuation of the lack of responses from several hundred companies, that they were probably not insured, or not seeing through the purport of our circular, did not think it worth while to reply.

The amount of insurance carried by the 172 insured companies reported was in the year ending April 1, 1888, $2,970,540, the premiums paid thereon amounting to $11,319.81. The losses collected during that year were $21,597.61, showing that year a gain to the insurance companies of $19,722.20, or 48 per cent. on the amount of money received. In the year following, the amount of insurance on central stations, as far as reported, was $3,099,473. The premium received on such amounts to $51.565.57. The loss during that year, however, amounted to only $11,000, leaving a good balance to the insurance companies. The decrease in the amount of losses shows also that great intelligence had been displayed in providing central stations and diminution of fire risks.

The total for the two years then has been: Insurance, $6,170,013; premiums collected, $92,885.38; losses paid, $32,697.61. You will see that the losses amount to but 35.2 per cent. on the premiums paid. A very small amount indeed. An amount that ought to reduce the premium on central stations fully one-half on their present rate.

The average amount of insurance on each station is $18,841.50.

The following interesting data were also obtained from the answers received by your committee out of the number of central stations responding to the circulars: We find that two-thirds, or actually 66 per cent., were built of brick, 22 per cent. of wood, 7 per cent. of stone and 5 per cent. of material unknown.

Only 69 stations of the 234 were built expressly for electric lighting purposes and exclusively used for that purpose.

We also looked into the causes of the fires that have occurred and find that 31.4 per cent. of the losses occurred by tramps setting fire to stables in proximity to stations; 28 per cent. spontaneous combustion; 8 per cent. crude oil for fuel; 1 per cent. wooden roofs over boiler; 2-10 per cent. lightning; 2-10 oil waste under engine room floor; 2-10 per cent. sulphuric acid, and 31 per cent. causes unknown.

With a desire to diminish fire risks in central stations, the New England Insurance Exchange has issued a form of what they call a model electric light station and insuring such a station at a very low rate. They also note on their circular, however, the gradual increase of the insurance rate by any one or more deviations from the rules laid down for a model station as printed in their circular.

(These conditions cited by Mr. Alexander have already appeared in THE ELECTRICAL WORLD).

	Cents.
The rate of insurance for such standard stations is	.75

Charges for Deficiencies as follows:

1. Frame	.10
2. Over two stories high; for third story (a basement will not be regarded as a story)	.05
3. For each story above third	.10
4. Shingle roof	.05
5. Cornice (except as provided in "Standard") on exposed station	.05
6. Sheathing, lathing and plaster, or any finish leaving concealed spaces, according to discretion, but not less than	.15
7. Stairs or elevators inside (except as provided in "Standard")	.10
8. Boilers and chimney (except as provided in "Standard") at discretion, but not less than	.15
9. Without any of the fire protection as required in "Standard" at discretion, but not less than (If only partial "Standard" requirements as to fire protection, at discretion).	.50
10. If fire pails and water only, not less than	.40

Electrical Arrangements.

11. Dynamos, unless as required by "Standard"	.25
12. Insulation, unless as required by "Standard," at discretion, but not less than	.25
13. Conductors, if concealed, at discretion, but not less than	.25
14. Conductors, if run under the floors, except as permitted by "Standard"	.25
15. Switch-boards, unless as required by "Standard," at discretion, but not less than	.50
16. Feeder equalizer boxes, unless as required by "Standard," at discretion, but not less than	.50
17. Care and attendance, unless as required by "Standard"	.25
18. Exposure, at discretion, but not less than	.10
19. Other occupancy of station, at discretion, but not less than	.10

Insurance on dynamos must be specific, and rate to be 25 cent in excess of schedule.

In view of all the investigations and information gathered, the committee would recommend that the National Electric Light Association form within its body an organization, having for its purpose the improvement of the electric services in general, the better education of the workmen engaged in the business of installing electric light and power plants, and the improvement of electric work generally.

The committee would especially recommend that examination boards be formed in the different districts composed of several States, where men seeking employment as dynamo tenders, wiring superintendents or others holding responsible positions in conjunction with electric light installing can be examined, and to whom can be issued by the organization a certificate of efficiency, stating the qualifications, and for what particular work the man possesses.

The committee would also recommend that members of this Association pledge themselves to have all men in their present employ examined in the manner proposed, and not to employ any person hereafter not provided with such certificate. In doing this the confidence of the insurance people will be speedily restored, and they will see that the electric light interest is beginning to have pride in its own work, and is trying to live down the bad reputation certainly earned by some individuals in former electric installations. Respectfully submitted,

P. H. ALEXANDER, Chairman,
H. B. CRAM,
M. J. PERRY,
M. J. FRANCISCO,
S. E. BARTON,
} Committee.

In addition to the letters incorporated in the report, Mr. Alexander read a number of letters from various underwriters' association, promising their assistance in the matter.

The privilege of the floor was then offered to the representatives of the insurance interests present.

Mr. BOUGHTON: I will not consume the time of the convention in entering again upon the branch of the subject that has already been covered. The situation of the boards in New York is very peculiar, and different from that of any other organization; and while we may not be able to pledge ourselves as far as some other boards may feel themselves authorized to commit themselves, it is only fair to say that we have worked for several years in the interest of good practice in the insulation of electric plants, and we want to co-operate with the electric light companies in furthering the good work, and will go as far in the matter of safety as the companies themselves are willing to go. They cannot be too safe for us, and we will gladly enforce, as far as the rules of our Board will permit us, the most stringent regulations that can be laid down. I say this in our behalf, but our jurisdiction is over very limited territory, the cities of New York, Brooklyn and Jersey City. We should be very glad to meet a committee from this organization and see if we could not agree—I believe we could agree—upon details for the proper conduct of the business of electrical companies and ourselves that should be satisfactory to both in the city of New York. (Applause.)

Mr. ANDERSON: We find in the city of New York that our architects are entirely ignorant of what should be done in the construction of electric light plant in a building. Now, we think that this convention could do a good work to invite a committee of the architects from the city of New York and other large cities, and have them educated so as to draw out the proper plans for the insulation of wires in the different buildings. We know it is the desire of all electric companies to do good work at a good price, but if they cannot do good work at a good price, they will do it at a small price; and by acting in concert to prevent this cheap work we will all be benefited, and I think that is the proper thing to get to work in harmony with you. I know they are very desirous of doing it. Some very expensive buildings are now in contemplation, and one point that I hope this convention will consider is to get the architects to work in harmony in their erection.

Mr. RYAN: As a representative of the Middle Department, I have been sent here to hear what you gentlemen have to say in regard to this matter. I heartily reiterate the sentiments expressed by the gentlemen here in saying that the association over which our department has control will put forth its best endeavors to meet you half way and try and do everything in our power to make the interest of the electric light stations as our own. I have been delegated by our association, and in that capacity I have examined a great many stations in Pennsylvania, and I have seen a number of electric light men, and the best of them complain bitterly of the competition of irresponsible people. It seems to me it lies within your power to help us out in this resrect, to make such rules as you think proper, and we will enforce them to the best of our ability. I think that by both associations working in harmony a great deal more good can be done than is thought of at this time.

Mr. S. E. BARTON: Before this subject is passed, I would like to state that I am not only a member of the New York Fire Underwriters, and a delegate from that association, but I am also a member of the New York State Association, which association has jurisdiction over this State outside of New York City. This circular was formulated at the July meeting; a committee was appointed to represent the organization at this meeting to-day. The delegate is not here. I can only say that the expression of feeling in the convention was a very hearty one, to co-operate with this convention here. If I may be permitted to say a word about one subject presented in this report, on the subject of insurance—it is the question of statistics given in regard to fire, loss and fire premiums on stations. The amount at risk and the amount of premium is so small compared with the amount of value involved in this great work, that the statistics presented may, or may not, be misleading. I could not, and no man who makes underwriting statistics his study at all, could, pass any opinion as to the merits of the statistics they have presented. I am very glad that the committee have commenced this work, and I hope by another year they will get it into different shape.

Mr. P. H. ALEXANDER: In making up the statistics, the gentleman probably notices that several companies have not replied. A good many of them are doubtless insured and paying premiums. While we have looked after the losses as far as possible, we have only one loss not recorded. The manager of that station told me that the amount collected was $38,000—a station in Boston. There is no doubt that to offset that we have not received the amount of premium paid by numerous companies insured and not reported. Therefore the statistics made up show merely the amount of premium received from the companies reporting, the amount of losses collected by the companies reporting, and the amount insured. Therefore, if we would take those 240 odd companies out of the 834 companies, and take the other companies and say, there is an average for 240 companies insured, of say $18,000 for each station, we surmise that the other companies not reporting would also have an average of $18,000 insurance. There is this immense amount of money that the insurance companies could gather in in premiums, and the losses proportionately would not be larger. You can see that, because the insurance companies do insure a good station at 75 cents. Now, it is for you to make such rules as to bring the stations up to conform with your requirements, and then your losses will doubtless be small, and you can afford to insure at that rate. Now, in regard to a suggestion made by Mr. Anderson about the architects some time ago, I was going to propose that all electrical companies installing plants make beforehand plans, and I have done it for a long time when I was in the business of installing plants—plans showing every floor, the wiring, etc. I showed the wires in colored pencils—No. 2 was blue, No. 4 red, and so on—and then submit that plan to the insurance inspector for approval before the wiring is done. This inspection business is an easy matter. The inspector only wants to see that the proper joints are made, fuse boxes properly arranged, and so on. Every company insuring an electric light station should have submitted to it a plan of the wiring made out in due form. I think that would simplify the matter, and might assist the parties installing a great deal.

Mr. RYAN: I would like to add a few words to what I have already said. I have here a few figures copied from the *Fire Chronicle*, published in New York, giving the statistics of loss for three years. In 1886 there were 29 risks burned. The property lost was $460,259. In 1887 there were 66 risks burned, giving a loss of $681,930. In 1888 there were 91 risks burned, giving a property loss of $1,587,213, showing an increasing loss every year. It may be in proportion to the number of wires already strung, or it may be bad work, bad plumbing, or some other cause. They are in the record of fires of electric light stations. In 1888 there were 75 electric light station fires. The aggregate property lost was $937,608. The aggregate insurance loss, $696,422. The insurance loss to the aggregate property loss was about 66 per cent. Those figures are a little different from those given by Mr. Alexander, and it seems to me that if those companies have not replied to him, it is perhaps because they are modest gentlemen, and do not want to tell what they suffered because of fires. The number from unknown causes was 20 per cent.; exposures, 28; aside from exposures, 25.

Mr. ALEXANDER: I want to say that Mr. Ryan takes the figures of losses incurred by the burning of electric light stations. If a whole row of houses should burn up, including an electric light station, the loss of the whole fire would be charged against the electric light station by the companies. We only ask how much the central stations have collected for their losses. I think that is the way you make it up, is it not, Mr. Ryan?

Mr. RYAN: Yes, I think so.

Mr. ALEXANDER: Here is a central station located on a block where the whole block burning down oaused a loss of $100,000 of property; that would be laid at the door of the central station.

Mr. RYAN: In writing the hazard, we generally charge for the exposures. If there is a loss, we charge the loss to the exposure.

Mr. DE CAMP: On one of our stations on which we had carried $100,000 of insurance, when the policies came due, we noticed the companies going off. We have an agent who has charge of all our insurance business. I asked him whether the rates were going to be advanced, and he said no, all those people are going off; they won't have it at all. Well, for what reason? It is an electric light station. That was the only answer I could get. It is an electric light station, a station equipped as fully, I think, as it may be equipped, with extraordinary good surroundings, built exclusively for a station, and still that was the only answer to the question raised. I would like to know whether that applies all the way through. I am aware that if we had some extreme risk alongside of us, we would be charged more on account of that risk. That I will accept. Now if a mill is put up, it is considered in a certain class of risk. If there is a dwelling house alongside of it, and the dwelling house takes fire and the mill is burned down, is that loss charged to the dwelling house?

Mr. RYAN: The general supposition would be that where the fire occurs that is the cause of the fire, and we attribute the fire to that cause. If it were a powder mill and burned up the whole street, the loss would be attributed to the powder mill. There was the hazard. That is the reason that we charge a greater per cent. of premium on a powder mill than we would on a dwelling house. Another thing that the gentleman makes mention of is his station being a first-class one in every particular. That may be one station out of one hundred. If the insurance companies could get every electric light station in the country and write a line on them, they might do so; but the impression has got abroad that the percentage of badly constructed electric light stations is such that the companies cannot keep a good average with the good ones.

Mr. BARTON: I think Mr. Ryan is wrong in one particular. The company does not charge the losses on all of the surrounding property to an electrical station. Every company doing a large business keeps its own statistics, and every insurance company is just as anxious for business as the electrical companies. They have insured electrical stations until the balance is on the wrong side, and their experience has been such that you have hard work to get a sufficient amount for an electric light station to make any large value. If you build them, in the next five years, so that they will not burn, you will find companies going for those risks as much as for other risks. If you make the risks so that they will not burn you will find us coming up for them.

Mr. FRANCISCO: In regard to fires in electric light plants, if you will investigate the subject you will find that the trouble has been generally with the risks themselves. Electric light stations have been placed in all sorts of clap-trap buildings of every description, and the fire, in nine cases out of ten, has been occasioned by some other business that has been carried on at stations besides the electric light business. After the Chicago convention, I spent several weeks in investigating the electric light stations, and traveled over 7,000 miles. I found a large number of stations where every species of business almost, was carried on in connection with the electric light business. Now, if a fire has occurred or does occur in any one of those stations, it would be charged to the electric light stations as the cause of that fire. Now in these statistics that this committee has obtained they found over 34 per cent. were caused by outside fires. Of course, these fires are nothing against electric light stations, and in my interviews with insurance companies—and I have had quite a number—and I have been in that business myself—I find that nine-tenths of all the insurance managers, in answer to my question why they did not take electric risks, have answered that they did not know where the hazard was, and therefore, in order to be on the safe side, they let them alone. Take a large number of the stations and investigate. The risk is not on the electric light plant, not on electricity, but on some other hazard that has been incorporated in that station, either from gross carelessness or something of that kind. For instance, here is one case of spontaneous combustion; 28 per cent. of fires in such places, the account says, is due to spontaneous combustion. Well, that is gross carelessness. Of course, that occurs from all risks. But we can wipe out that hazard if we would only remove the

cause of spontaneous combustion, and that is found in every class of risks; you meet it everywhere. Take that out, and take all of those things out which are outside practically of the electric light part of the station, and you have as good a risk as can be found anywhere. There is the point, and that is the point where the electric light people have got to come right down to. Each manager must look to his own station, and remove these hazards which are outside practically of his business and put them in proper shape, and then we will have no difficulty.

Mr. MORRIS: I think if we can't get the companies to make this discrimination in favor of good stations, then our plan is to form a mutual co-operative insurance company of our own, and we can make the discrimination that ought to be made; we will take the good stations and wipe out the bad stations. And I move upon that point that this committee be continued, and that they formulate or prepare some plans looking to the formation of an insurance company by electric light companies.

Mr. LYNCH: I would like to second that proposition. I would also like to ask some of the gentlemen who have been furnishing insurance statistics a question. I agree with Mr. De Camp, Mr. Morrison, and several other electric light men. I think it very hard that the electric companies should bear all of the insurance that is lost through any fire in the electric light works, and I would like to ask the insurance men if the loss sustained some fifteen years ago by the burning of the larger portion of the business portion of Chicago by fire—which, as we all know, was caused by a cow kicking over a lamp in a one horse stable—I would like to ask them if all the losses sustained in that fire was laid to that cow stable?

Mr. S. S. LEONARD: For the last two years I have been fighting insurance companies to the best of my ability. Two years ago our rate was $1.50 and $1.75. We commenced to use a fuel oil and were charged one per cent. additional. All right, we said, we would pay it because we wanted to find out about the oil, and our method of handling it was very crude, and we thought that after we had found out whether it was what we wanted, that we would undoubtedly get a lower rate. We did not get the lower rate; they still charged the one per cent. additional, and yet every insurance man that has been there has said that he cannot possibly see wherein the danger lies from the use of that oil. We can get no satisfaction from the companies whatever—that is, no satisfaction from them whatever toward reducing that rate.

Mr. BARTON: In New England the greatest willingness exists, as I have stated, on the part of the electric light station owners to make any changes whatever. The result is, that there is scarcely a station in New England to-day but is undergoing changes, and the stations to-day are rated—I think the average rate upon them would be something about 2½ per cent. in the present condition. In less than six months from now I predict that the average rate on stations in New England will be nearly 1 per cent. We have written lots of them to-day at 75 cents, and some most elegant stations are being built, and no less than twenty of the most modern stations are going up to-day. The work of perfection seems to have taken the strongest hold with us, and every electric light company that is contemplating building stations to-day is trying to do it in accordance with the standard that we have established, and some of them are even going past our standard; and, as Mr. Henthorn, when he comes to his paper, will show you, there is a station in Providence that is almost non-combustible, and one in Waterbury on the same principle. It is just as easy to build them that way, and that is the tendency to-day.

Mr. J. F. MORRISON: I want to call the attention of the members of the association to the fact that the proposition to establish a mutual insurance company within the association is not new. On Feb. 10, 1886, at the Baltimore Convention, a proposition of a similar character was introduced. I am not going to take up any of the time of the convention, except to suggest to the members that they refer to the back numbers of the reports to see what action washad. I was opposed to it then, and am opposed to it now. When you come to the fourth meeting of this body, held in Detroit, Mich., you will find there that a committee appointed at a previous meeting to look into this question, through their chairman, Mr. C. J. H. Woodbury, an insurance expert, reported adversely on the mutual insurance project, and it died. Mr. H. M. Cleveland was the originator of the idea of mutual insurance within the National Electric Light Association. There were a number of gentlemen who were ready to organize and operate an association of that kind for the benefit of the Association, I take it. The investigation which followed determined then that it was not a wise thing for the National Electric Light Association to take any steps in this direction. I believe that every man should mind his own business, if he can, and to that end I think insurance people should attend to the insurance and the electric light people to the making of light. I think the jack of all trades is master of none. When you go into a foreign field you have either got to learn the business yourself, or buy the services of some man who already knows it. A man who has got sense enough to understand the electric light stations, is too old to learn anything else, I take it; and if you go into that business you have got to take men who are doing it for themselves. I arose to refer the members of the association to these two items of history, the history of their own association; and when you read these you will find what has been done in the past, and that may perhaps to some extent govern your actions in the future. I have very little to say on the question of insurance, for I had my say in our companies, that is, the companies with which I am connected in the State of Maryland. Our stations are so built and equipped that there is little or no danger of fire. We have men patroling them all the time, day and night; the buildings are almost fireproof. If I had an old tumbledown shanty like a good many of you, I should want to be insured, too. I find that a successful company never has a fire; but you take a company that is losing three or four thousand dollars a month, and a fire is a godsend to them. But you take a first-class station, and you have a good business, and of course the laws of business require you to insure. We insure; I think our insurance is about 1 per cent., or 1¼ per cent. It is a matter that I give very little attention to. I don't bother my head about it. We are insured for a considerable amount; I don't remember how much it is. We applied for insurance on a station, one-half of which is built of wood. The insurance men came along and looked it over and said, you have got to make some radical alterations, and they amounted to $640. The original insurance, I think, on the structure amounted to nearly that much per annum in premiums. We made the changes they suggested; had hose put in, made connection with pumps, and they insured us for 1¼ per cent. If there is a case of injustice, I take it, through this very committee, if it continues to do the work in the next six months that it has done in the past, a better condition of things will obtain, and that such a condition of affairs as Mr. DeCamp suggests will be a very rare occurrence.

Mr. FRANCISCO: My experience has been that if you make a risk proper and right in every respect, that stock insurance sompanies will give you rates just as cheap as you can get it in the mutual. If you are going to run a mutual insurance company, you have got to do it on the same principle as they do. Members of this company don't want to pay some poor station when they can get their own station insured in some other company. You have got to have money enough to pay your expenses. If you put your stations in proper shape you can get a stock company to carry it. Now, as an illustration, take my own station. Before I took charge of it they could not get insurance; now I am getting it at 1¼ per cent., and I made the changes required by the insurance companies under the basis of the New England Exchange. I could make additions to that by which I could reduce that rate. And it has been my experience that if you put your stations in proper shape the stock companies will make your rate as low as any mutual company can.

The PRESIDENT: The motion is that the report of the committee on Harmonizing the Electrical and Insurance Interests be received and filed, and the committee continued with instructions to take under advisement the feasibility of establishing a mutual insurance company, and that the committee also invite representatives of the insurance interests to meet them at such time and place as they may designate, with a view to taking some tangible action looking to inspection and the establishment of electrical exchanges to cover the whole country. Carried.

Mr. CHARLES A. BROWN: Then I offer the following resolution:

Resolved, That a committee of three be appointed by the president and instructed to prepare and present to the proper committee of Congress a petition on behalf of the National Electric Light Association for the abolition of the custom duty on copper, ingot, wire plates, sheets, bars and rods.

Mr. G. M. PHELPS: I second Mr. Brown's resolution, and move its adoption.

Mr. MORRISON: If we could get Congress to adopt that I think that the work of the National Electric Light Association will have reached the point which will entitle it to the grateful remembrance of every citizen of this country who has the good of his country at heart. I am delighted that it came from a gentleman from Chicago. I would be very glad if every gentleman engaged in other lines of business that impinge on our affairs would present a precisely similar case, and nothing would give me greater pleasure than to welcome Mr. Brown and his colleagues into the ranks of the free traders.

Mr. PHELPS: I am very glad that Mr. Morrison has proceeded with such a hearty commendation of the resolution. It does not seem to me at all certain, and, in fact, very probably not very likely, that the adoption of this resolution would secure the abolition of the copper tariff next winter, but it would be a move in that direction. Those who have read attentively the public journals on the subject of the copper tariff may observe that even protectionist journals realize that this is a tariff which ought to go. It seems to me eminently proper that this body should memorialize Congress on this subject, in view of the immense proportion that copper bears to all electric plants. I have not at this time the precise figures on that point, but it is my impression that copper enters into the cost of electric plants in general to the extent of at least one-third, perhaps more. And the further reason that I have is this, that whatever will reduce materially the cost of electric plants will indirectly, if not directly, increase your business, the business that the members of this association are engaged in. All are desirous of bringing the production of electric light down to as low a cost as possible, and the cost of the initial plant is a very large proportion of the cost of production. And, therefore, I have risen to second this resolution. It is a move toward the future prosperity of electrical interests, and we have good reasons for taking it up. The tariff is a useless tariff, and the copper men themselves say that they can make their copper for six or seven cents per pound; and while the present differences in prices in this country and Europe are not greatly pressing, we know what it has been through the lack of competition that has been existing for several years. And this tariff is the most powerful instrument in behalf of those who want to use it for speculations.

The PRESIDENT: I am a protectionist, but I believe first in protecting ourselves, and the resolution as offered by the gentleman from Chicago, it seems to me, is right in line of the protection of the electrical industries of this country. I think that we should protect ourselves, not only against our foreign cousins, but against our home friends and relatives, at certain times, and I think this is one of the times.

The PRESIDENT put the question and declared the resolution adopted, and appointed on the committee Messrs. Brown, Phelps and Morrison.

Mr. HENTHORN then read his paper on the station of the Narragansett Electric Light Company, Providence:*

The discussion of this paper was postponed till the afternoon session.

WEDNESDAY, AFTERNOON SESSION.

The Convention was called to order at 2:30 P. M. by the President, who then introduced Mr. F. A. Wyman, of Boston, who delivered the following address on

THE CONSTITUTIONALITY OF EXECUTION BY ELECTRICITY.

I have been honored by an invitation to say a few words to you upon the subject of putting criminals to death by electricity.

I maintain that at the present time, under the existing laws, except in a few States, legislatures cannot authorize and courts can not inflict such punishment.

The theory that "all men are born free and equal, and have certain natural, essential and inalienable rights, among which may be reckoned the right of enjoying and defending their lives and liberties, that of acquiring and protecting property, in fine, that of seeking and obtaining their safety and happiness," lies at the very foundation of the government of each State of our Union.

When a man takes from his neighbor's rights by crime, government takes from his rights by punishment. Punishment is to "reform the offender; to deter him and others from committing like offenses, and to protect society" (*Bouvier's Dict. Punishment*).

*Owing to delay in receipt of this paper and illustrations, it has been printed later on page 118.

The criminal should suffer for his misdeeds to gain these ends of punishment, but punishment should go no further.

The people of each State decide what laws are necessary for their safety and happiness, and they have committed to writing the fundamental principles on which they desire to be governed in instruments called Constitutions. With these Constitutions all act of legislatures must harmonize or be null and void.

Constitutions are simply articles of co-partnership, and we are al partners (some active, some silent), and are working under the partnership articles. It is frequently the case that an article is inserted "that no partner shall become surety 'upon bonds.'" Now, if at any time it becomes desirable for one partner to go upon such bond, then is the time to change the articles of co-partnership (or amend the Constitution), and not go and violate the provisions thereof. It is not as though the Constitution was like the laws of the Medes and Persians, unalterable, for the Constitution can be changed at any time through the channels provided by the instruments themselves. *Laws* are made by bodies of men chosen for brief periods on account of their ability to cope with a general variety of subjects, and who are sworn to support and uphold the Constitution under which they are acting. *Constitutions* are made and changed by the direct voice of the people acting upon some particular subject, and with a direct bearing upon the subject. We each of us live in our respective States because we like the Constitution of the State.

If at any time we are dissatisfied, we can, if a sufficient number of our fellow-citizens think our views are right, change the Constitution. Failing in that, and not liking to live under a rule of a majority, I do not think we have a right to complain, especially with such good walking to Canada and Mexico, and steerage passage to Europe only $12. If, then, some believe in the efficacy of electric ity to punish criminals, and if, as I maintain, such mode of punish ment is now illegal, at least in nearly all States, such believers can try to change the Constitution under which they live, and if unsuccessful and dissatisfied, can seek green fields and pastures new.

In the "Report of the Commission to Investigate and Report the most Humane and Practical Method of Carrying into Effect the Sentence of Death in Capital Cases," appointed in New York in 1886, the following list is given of the various modes of capital punishment: *auto da fe*, beating with clubs, beheading, decapitation, blowing from cannon, boiling, breaking on the wheel, burning, burying alive, crucifixion, decimation, dichotomy, dismemberment, drowning, exposure to wild beast, flaying alive, flogging, knout, garrote, guillotine, hanging, *hari kari*, impalement, iron maiden, *peine forte et dure*, poisoning, pounding in mortar, precipitation, pressing to death, rack, running the gauntlet, shooting, stabbing, stoning, strangling, suffocation.

The phrase "cruel and unusual punishment" first occurs in the declaration of rights presented by the convention to William and Mary, before settling the throne upon them in 1689.

"On Feb. 13, 1689," in the words of *Corbett's Parliamentary History*, Vol. 5, p. 108, "this day, about ten of the clock, Mr. Speaker, attended with the mace, and the house of commons following him in a body, went in their coaches to Whitehall, where the right hon. the marquis of Halifax, Speaker of the house of lords, with the house of lords, being placed on the right side of the door, within the Banqueting house, and the right hon. Henry Powle, esq., Speaker of the house of commons, with the commons on the left side of the door of the said Banqueting House, waited the coming of the Prince and Princess of Orange, who immediately after entering in at the upper end of the Banqueting House, came and stood upon the step under the canopy of state, where being the Speakers of both Houses, together with the lords and commons that accompanied them, were brought up by the gentleman usher of the black rod, making three obeisances, one at the lower end of the room, one in the middle and one at the step where their highnesses stood. And then the Speaker of the house of lords acquainted their highnesses that both houses had agreed upon a Declaration to be presented to their highnesses which he desired might be read, which being granted by their highnesses, the Clerk of the house of lords by order of that house, read the Declaration that followeth:

"'WHEREAS, the late king James II., by the assistance of divers evil Counsellors, Judges, and Ministers employed by him, did endeavor to subvert and extirpate the Protestant Religion, and the Laws and Liberties of this kingdom. * * * And WHEREAS, of late years, partial, corrupt, and unqualified persons have been returned on Juries on Trials, and particularly divers Juries in Trials for High Treason, which were not free holders; and excessive bail hath been required of persons committed in criminal cases, to elude the benefit of the laws made for the Liberty of the Subjects; and excessive Fines have been imposed; and illegal and cruel Punishments inflicted. * * *

"And WHEREAS, the said late King James II., having abdicated the government, and the throne being thereby vacant * * * And thereupon the lords, spiritual and temporal, and commons, pursuant to their several letters and elections, being now assembled in a full and free representative of this nation, taking into their most serious consideration the best means for attaining the ends aforesaid, do in the first place (as their ancestors in like case have usually done) for vindicating and asserting their ancient rights and liberties declare: * * * That excessive bail ought not to be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted.'"

The people of nearly every State have placed limits upon the power to punish for crimes. The Eighth Amendment to the Constitution of the United States declares that cruel and unusual punishment shall not be inflicted.

There is a similar limitation in the Constitutions of the following States:

	Const.		Const.
Colorado	1876	Ohio	1851
Georgia	1868	Oregon	1857
Indiana	1851	South Carolina	1868
Iowa	1857	Tennessee	1870
Missouri	1875	Virginia	1870
Nebraska	1875	West Virginia	1872
New Jersey	1844	Wisconsin	1848
New York	1846		

The people of the following States, in their Constitutions, declare that "cruel *or* unusual punishments shall not be inflicted."

	Const.		Const.
Alabama	1875	Massachusetts	1780
Arkansas	1874	Michigan	1850
California	1849	Minnesota	1857
Florida	1868	Mississippi	1868
Kansas	1859	Nevada	1864
Louisiana	1868	New Hampshire	1792
Maine	1875	North Carolina	1876
Maryland	1867	Texas	1870

"Cruel punishments" are forbidden in:

Delaware, Const. 1831, Art. I., Sec. 11.
Kentucky " 1850, Bill of Rights, Sec. 17.
Pennsylvania, Const. 1873, Dec. of Rights.
Rhode Island, " 1842, "

The Constitution of Illinois says: "All penalties shall be proportioned to the nature of the offense." The Constitution of Vermont, provides that all fines shall be proportioned to the offenses. But no restriction exists in the Constitution of Connecticut. While it may be true that the Legislatures of Connecticut, Illinois and Vermont have power to punish crime with death by electrical current, no such power exists in the law-making bodies of all other States, as such punishment is unusual and also cruel. For a few minutes let us look at the origin and history of such a restriction in Constitutions, then at the opinions of judges as to its purpose and meaning.

The proceedings in Congress on the amendment were as follows:

On Monday, Aug. 17, 1789, the House, as a Committee on the Whole, on the state of the Union, in considering in order the amendments to the Constitution proposed by Mr. Madison, took up the amendment, now numbered VIII., "excessive bail, etc." (then sixth clause, fourth proposition).

According to the Annals of Congress, which were the "debates and proceedings in the Congress of the United States," compiled from authentic materials by Joseph Gales, Sr., on page 754:

"Mr. Smith, of South Carolina, objected to the words 'nor cruel and unusual punishments,' the import of them being too indefinite.

"Mr. Livermore: The clause seems to express a great deal of humanity, on which account I have no objection it, but it seems to have no meaning to it; I do not think it necessary. What is meant by the terms excessive bail? Who are to be the judges? What is understood by excessive fines? It lies with the court to determine. No cruel and unusual punishment is to be inflicted. It is sometimes necessary to hang a man; villains often deserve whipping and perhaps having their ears cut off, but are we, in future, to be prevented from inflicting these punishments because they are cruel? If a more lenient mode of correcting vice, and deterring others from the commission of it, could be invented, it would be very prudent in the legislature to adopt it, but until we have some security that this will be done, we ought not to be restrained from making necessary laws by any declaration of this kind.

"The question was put on the clause, and it was agreed to by a considerable majority."

On Thursday, August 21, 1789, on the report of the Committee of the Whole, this clause was adopted.

The courts have spoken as follows upon the meaning of this phrase cruel and, or cruel or, unusual punishments.

In New Mexico the Court said: "All punishment is more or less cruel, and the kind of punishment to be inflicted upon criminals to induce reformation, and repress and deter the thief from a repetition of his larcenies has generally been left to the sound discretion of the law-making power. * * * The word cruel, as used in the Amendatory Article of the Constitution, was no doubt intended to prohibit a resort to the process of torture resorted to so many centuries as a means of extorting confessions from suspected criminals, under the sanction of the civil law. It was never designed to abridge or limit the selection by the law-making power of such kind of punishment as was deemed most effective in the punishment and suppression of crime."—Garcia vs. Territory 1, Mexico 417.

Our United States Supreme Court said: "Difficulty would attend the effort to define with exactness the extent of the constitutional provision, which provides that cruel and unusual punishments shall not be inflicted; but it is very safe to affirm that punishment of torture, such as there mentioned by the commentator referred to (Blackstone), and all others in the same line of unnecessary cruelty, are forbidden by that amendment to the Constitution."—Wilkerson vs. Utah, 99 U. S., 135.

A judge of the Supreme Court of New York said: "It is difficult by a general definition so to define the phrase 'cruel and unusual punishments' as to cover its entire meaning, and that which in the judgment of one man is cruel may not seem to be so to another, and that which is unusual to the sight of one individual is quite usual to that of another. * * * Acts are startling only by comparison. The punishments inflicted by barbarous nations are neither cruel nor unusual when measured by their standards, and they become so only when measured by the more humane one of civilization. Nay, in some of the States of our Union there have been and now are statutes prescribing punishments which the almost universal judgment of our commonwealth would pronounce 'cruel and unusual,' and yet such statutes have there been upheld. * * * Evidently, then, the law of the State of New York prescribing punishments for crimes committed within a certain locality must be judged by its own general standard. Its right to change such general standard is unquestioned." And the judge maintains that the prohibition extends to the *degree* of punishment as well as to the kind.

"If, then," he adds, "it may be asked, is it just to pronounce any punishment 'cruel and unusual' because not of a *kind* to which we have been accustomed, and therefore shocking to our moral sense, why is the same rule unsound when the *extent* thereof is to be judged?"—Matter of Bayard, 61 How. Pr. 300.

In this case of Bayard, a man who had been convicted of petit larceny in Cohoes, and was sentenced to imprisonment for one year, which was greater than the punishment for a similar offense elsewhere in the State, was discharged by a single judge of the Supreme Court, but this decision was reversed by the General Term. In pronouncing the decision in the latter case, 63 Howard Pr., Rep. 76, the court says that declaration (Bill of Rights, 1689) recites crimes and errors which had made the revolution necessary. "These recitals consist of the acts only of the former king and the judges appointed by him, and one of them was that illegal and cruel punishment had been inflicted.

"The punishments complained of were the pillories, slittings and mutilations, which corrupt judges of King James had inflicted without warrant of law, and the declaration was aimed at the acts of the executive, for the judges appointed by him and removable at pleasure were practically part of the executive.

"It clearly did not then refer to the degree of punishment, for the criminal law of England was at that time disgraced by the infliction of the very gravest punishment for slight offenses, even petit larceny being punishable with death.

"But the declaration was intended to forbid the imposition of punishment of a kind not known to the law, or not warranted by the law.

"The courts have rarely had occasion to construe the meaning of the phrase 'cruel and unusual punishment.' * * * The text writers * * * seem to understand it as prohibiting any cruel and degrading punishment not known to the common law, and probably also those degrading punishments which in any State had become obsolete when its existing constitution was adopted, and punishments so disproportioned to the offense as to shock the sense of the community." * * *

In Done vs. The People, 5 Parker, New York, 382, Campbell, J., enumerates the various punishments in England and New York, and adds: "I have run over this brief outline history of the punishment of death for crimes anterior to the Revolution, for the purpose of showing that there was a cause for the declarations in the bill of rights, and also as it tends to shed light on the subsequent legislation in relation to capital punishment in our State. It will be seen that under that legislation the punishment of death must be inflicted by hanging, and that burning at the stake, quartering and disemboweling, breaking in the wheel and gibbeting alive, would no longer be allowed, whether the power to do so was derived from colonial acts, from the common law, or whether the condemned parties were Indians, negroes or white men. Our bill of rights had declared that neither unusual nor cruel punishments should be inflicted. Burning at the stake, if it had not been an unusual, was a cruel punishment; so was breaking in the wheel, and so was gibbeting alive. All these punishments had been inflicted while New York was an English province."

In Alabama, Turnipseed vs. Alabama, 6 Ala., 664, where a statute prohibited the infliction of any "cruel or unusual punishment" on a slave, and an indictment charged a man with inflicting "cruel and unusual punishment," the Court said: "True, the statute makes two offenses, or rather does not require that the punishment inflicted upon a slave shall be both *cruel* and *unusual* to subject the offender to its exactions; it is enough if the proof shows it to be either one or the other. To punish cruelly is one, and unusually is another breach of criminal law. The statute, it is apprehended, does not use the epithets as synonymous, nor in contrast with each other; but it was merely intended to make the enactment sufficiently broad to embrace a high offense against good morals, no matter under what circumstances commited. *Cruel*, as indicating the infliction of pain of either mind or body, is a word of entensive application; yet every cruel punishment is not, perhaps, unusual; nor, perhaps, can it be assumed that every uncommon infliction is cruel. But be this as it may, there may be punishment that is both cruel and unusual."

The following punishments have been held to be not within the prohibition of the Constitutions. In New York and Pennsylvania, disfranchisement and forfeiture of citizenship.—Huber vs. Reily, 3 Smith, Pa., 112. Barker vs. People, 3 Cowen, 686.

In Missouri, labor on the public streets.—Ex parte Bedell, 5 Western Reporter, 111.

In Vermont, cumulative punishment.—State vs. O'Neil, 1 New Eng. Rep., 775.

In Tennessee and Massachusetts, fine and imprisonment.—Ligan vs. State, 3 Heisk, 159. Commonwealth vs. Hitchings, 5 Gray, 486. Pervear vs. Commonwealth, 5 Wall, 475.

Under Federal Law, death by shooting.—Wilkerson vs. Utah, 99 U. S., 135.

In the above case of Commonwealth vs. Hitchings, the Court says: "A law subjecting a person making a single unlawful sale of intoxicating liquor, for a first offense to the payment of a fine of ten dollars and costs of prosecution and imprisonment in the House of Correction, not less than twenty nor more than thirty days is not within the prohibition."

In Georgia, imprisonment of one convicted of assault with intent to kill, for ten years in the Georgia Penitentiary is not cruel and unusual punishment, because he is afflicted with epilepsy.—Fogarty vs. State, 5 South East Rep., 782.

In Kentucky a fine of one cent, and imprisonment for three years in a county jail for an assault with a cane and a cowhide, is held not to have been cruel punishment.—Cornelison vs. Commonwealth, 84 Ky., 583.

In Texas, imprisonment for five years in a penitentiary for stealing a horse, the term to begin on the expiration of an equal term for stealing another horse, is not a cruel or unusual punishment.—Lillard vs. State, 17 Texas Appeals, 14.

A fine of $50 and imprisonment at hard labor in the House of Correction for three months for keeping and selling intoxicating liquors is not cruel or unusual.—Pervear vs. Commonwealth of Mass., 5 Wall, 475.

In Virginia the Court said: "The common law undoubtedly considered corporal chastisement by the infliction of blows on the bare back as one of the ordinary modes of punishment, and such punishment has been held not to be within the prohibition of our State Constitution, against cruel and unusual punishments."—Commonwealth vs. Wyatt, 6 Randolph, 694.

In Tennessee the Court said: "Our sturdy ancestors not only allowed it in the case of criminals, sailors and soldiers, but considered it a proper discipline for their wives and children."—Cornell vs. State, 6 Lea, 629.

So that in Virginia and Tennessee "corporal punishment by the infliction of blows on the bare back" is allowed.—Aldrich vs. Com., 2 Va., Cas., 447. Under Federal Law flogging was permitted in 1835. U. S. vs. Collins, 2 Curt., 194, but prohibited in 1850.—U. S. Rev. Stat., 4,611. In Maryland and New Mexico whipping was allowed.—Foote vs. State, 59 Md. 266; Garcia vs. Territory, 1 New Mex., 417. Thus far we have enumerated only those decisions which have decided certain punishments to be legal, or the judge exercised his discretion permitted by statute. The courts hold such punishments to be unconstitutional and void only in clear cases of conflict with the fundamental law of the Constitution. We will now examine the cases where punishments have been held to be illegal because cruel and unusual.

In State vs. Giles Driver, 78 North Carolina, 423, a husband while in a passion and under the influence of drink, whipped his wife with a switch, and with such severity as to leave the marks for two or three weeks, and kicked her once. He had whipped her before, but not with the same severity, and when brought to trial for the last whipping pleaded guilty. The judge sentenced him to imprisonment in the county jail for the space of five years, and at the expiration thereof to give security to keep the peace for five years in the sum of five hundred dollars with sureties. He was unable from poverty to appeal, but afterwards brought the case up for review by certiorari on the ground that such sentence violated the State Constitution which forbids "cruel and unusual punishments." The Court in its opinion refer to the case of State vs. Miller, 75 North Carolina where a man was sentenced to imprisonment in, the county jail and where the Court awarded a new trial on certain grounds, strongly intimated that the sentence was unconstitutional. The Court said: "In our case his Honor imprisoned the defendent for five years, not in the penitentiary where he may live so long, but in the county jail where it is strongly probable that confinement and fetid air would cause a lingering death. The oldest member of this Court does not remember an instance of five years' imprisonment in a county jail for any offense." In this case of State vs. Driver the Court held the punishment to be not only "unusual" but unheard of, and also to be "cruel."

In Ho Ah Kow vs. Mathew Nunan, 5 Sawyer, 552, an ordinance directed against the Chinese, ordering persons imprisoned for a certain misdemeanor to have the hair of his head "cut or clipped to an uniform length of one inch from the scalp thereof," was held to be illegal. Mr. Justice Field says: "The ordinance was intended only for the Chinese in San Francisco. This was avowed by the Supervisors on its passage, and was so understood by every one. The ordinance is known in the community as the 'queue ordinance,' being so designated from its purpose to reach the queue of the Chinese, and it is not enforced against any other persons. The reason advanced for its adoption and now urged for its continuance is that only the dread of the loss of his queue will induce a Chinaman to pay his fine. That is to say, in order to enforce the payment of a fine imposed upon him, it is necessary that torture should be super added to imprisonment. * * * Probably the bastinado, or the knout, or the thumb-screw, or the rack would accomplish the same end; and no doubt the Chinaman would prefer either of these modes of torture to that which entails upon him disgrace among his countrymen, and carries with it the constant dread of misfortune and suffering after death. * * * The complaint in this case shows that the ordinance acts with special severity upon Chinese prisoners, inflicting upon them suffering altogether disproportionate to what would be endured by other prisoners if enforced against them. Upon Chinese prisoners enforcement acts as 'a cruel and unusual punishment.'"

That the infliction of death by the electrical current is illegal in those sixteen States whose constitutions forbid "cruel *or* unusual punishment" can hardly be doubted; for although under certain circumstances courts construe "or" to mean "and," and "and" to mean "or," yet this is true only where the whole language plainly requires such construction. No one can honestly deny that the punishment of criminals by death from electricity is not only unusual but unprecedented. It is idle to say that the punishment is death, and such punishment is usual. Such argument would prove the uselessness of any constitutional provision, for a sentence to death by burning, by gibbeting, by the rack, by any horrible torture, would be authorized, as it would merely sentence to death, and punishment by death is usual and not cruel! The *means* by which the punishment is inflicted are clearly within the limits of the restrictions.

Such punishment is unusual, but is it cruel? I maintain that the attempt to put to death by electricity is cruel. Think of the agony experienced by the prisoner on being put into the rack (for it is no more or less than a rack), upon which he is to be killed at some time, perhaps ten minutes, perhaps an hour. The man does not live who can tell how much electricity it takes to kill a human being. I have personally, within ten days, conversed with a man who took a full 2,500-volt shock and he is alive and well. He was unconscious for some time after receiving the shock, but during the interval between the shock and the unconsciousness he realized that he had been struck by some terrible force. A man may have heart disease and be easily frightened to death by the sudden opening of a door, still you would not undertake to punish criminals by scaring them to death by opening doors. You may be able to frighten a man to death by means of the rack now proposed without even connecting the paraphernalia with a dynamo. We all remember the well-authenticated case of the man who, having been sentenced to death for crime, consented to be put to death by being blindfolded and having an artery in his arm opened; then when the surgeon scratched his skin only and did not draw a drop of blood, but let warm water strike his arm and fall drop by drop so the criminal could hear it, the criminal slowly lost strength, and finally died by that treatment.

In the examinations which have been held before a referee in New York, to determine whether the punishment of death by the electrical current to which Kemmler has been sentenced is unconstitutional, because "cruel and unusual," many experts have testified that no means existed by which to tell whether any amount of electricity would certainly kill every man, so greatly differed powers of resistance; men who had been struck by lightning have related their experiences, showing that even the immense power of nature's battery has sometimes failed to kill; men who have received shocks from wires charged with currents of varying force have told of their sensations, and the horrible pain they suffered.

When the State brings forward men who testify to their belief that death by the electrical current is certain and painless, there arises a conflict of evidence. When experts disagree, who shall decide? In the testimony before the referee, and in the articles and discussions in newspapers and magazines, the preponderance of evidence has been that such punishment is cruel, or at least enough evidence of its cruelty has been given to raise a reasonable doubt in in the mind of an ordinary man; enough surely to prevent humane and enlightened legislators in other States from adopting such means of punishment in the present age of uncertain knowledge of electricity, and enough to induce the legislators of New York to repeal their own law requiring such mode of punishment.

But the question now before us is whether the courts of New York will pronounce such punishment unconstitutional because "cruel and unusual," and not whether the law-making body of New York would, with all the evidence then before it which now exists, have refused to legalize such a cruel and unusual punishment. To enable the courts to declare that a statute is unconstitutional, its invalidity must be shown beyond a reasonable doubt. As the Supreme Court of Massachusetts said in Talbot vs. Hudson, 16 Gray, 422: "But it is to be borne in mind, that in determining the question whether a statute is within the legitimate sphere of legislative action, it is the duty of courts to make all reasonable presumptions in favor of its validity. It is not to be supposed that the law-making power has transcended its authority, or committed under form of law a violation of individual rights. When an act has been passed with all the requisites necessary to give it the force of a binding statute, it must be regarded as valid, unless it can be clearly shown to be in conflict with the Constitution. It is therefore incumbent on those who deny the validity of a statute to show that it is a plain and palpable violation of constitutional right. If they fail to do so, or leave room for a reasonable doubt upon the question whether it is an infringement of any of the guarantees secured by the Constitution, the presumption in favor of the validity of the act must stand."—See also State vs. Lasater, 9 Bax., 587.

In the case of Kemmler there is, as I have before said, either a preponderance of evidence that punishment by the electrical current is cruel and unusual, or at least a reasonable doubt exists as to its non-cruelty; and in my opinion it can be said with truth that it has been proved *beyond a reasonable doubt* that it is cruel.

I have tried to show that the power to punish lies in the law-making bodies except so far as they are restrained by constitutional provisions; that cruel punishments are forbidden in some States, "cruel and unusual" in others and "cruel or unusual" in others; to the history of such a restriction has been added the words of judges in construing it. My endeavor has been to show that punishment of death by means of the electrical current is so cruel that legislators ought not to adopt it, so cruel that the legislators of New York ought to repeal their law, and so cruel that the courts of New York ought to pronounce the statute unconstitutional.

Dr. MOSES: Mr. President and gentlemen of the association: We all have a very deep interest in the subject which has been just broached by Mr. Wyman, of Boston. I did not have the pleasure of listening to all of his paper, but I think in one or two sentences he laid very clearly before us his belief and his proof that killing by electricity is a cruel and an unusual punishment, and therefore violating all the constitutions of the different States of this country. That is a view which I think will prevail ultimately, and lead, as we hope, to a repeal of this very obnoxious law whose discussion is now agitating our press and our people. The history of that law it would be well for us just now to consider, after which I will offer a few remarks upon statistical information which I have gathered, through the kindness of the members of this association and of others not connected with it; and then proceed to show that the main object of the law is violated in the act of carrying it out; for, although the object of the law was a philanthropic one, the method by which the killing is to be conducted is one of the most barbarous that could possibly be devised, and therefore altogether unnecessary in carrying out the stern mandate of the law.

Two years ago many of us, I among the number, received a communication, from Mr. Elbridge T. Gerry, the noted philanthropist of New York, in which he requested some opinions or expression of views on a proposed law of killing by electricity. But I happened to be away, and although he once or twice wrote to me after that I did not receive his letters in time, and consequently did not partici-

pate in the deliberations which led him finally to recommend to the Legislature of the State of New York that hanging should be abolished and killing by electricity should be substituted for it. The law was put upon the statute books, but very soon it became apparent that it was a hasty proceeding. We, meeting at our several conventions, were too much occupied with the useful and the practical side of our art and science to engage in any considerations of such a far-fetched use of electricity as killing. The result was that we allowed the law to go almost unnoticed upon the statute books, and finally, when the time came for a criminal to be condemned, we found ourselves placed in that unenviable position of representing an interest the chief instrument of which was about to become a public executioner. Then by an instant revulsion of feeling we became conscious of the fact that some one or some rival interest had been at work for the purpose of bringing opprobrium upon electricity. This view was considered far-fetched in the beginning; but afterwards, when we saw the methodical, and cruel calculation, the persistence of certain individuals —I might say one individual—in constantly bringing before the public the fact that the law had to be executed, and then finally trying to concentrate public attention upon it in such a way as to bring a further opprobrium, upon one branch of our beloved art and science—when we saw that, we were aroused. By a sort of spontaneity of action protests were sent forward from all quarters. The first criminal who was condemned to death under the law has not yet been killed, but an effort has been made to prevent his death by electricity, and he is to-day in a most unfortunate position. Only recently, at Buffalo, the matter has been argued, after a prolonged hearing before a referee in New York, and an enormous amount of testimony of a very conflicting nature has been brought to bear. It is a sad thing that we have conflicting testimony, because the fact that certain experts gave their opinions *pro* and *con* as to the certainty of death has been taken by the press to convey the idea that an uncertainty has existed in the minds of those who use the current in great quantity as to the desirability of using it for killing purposes.

This action in New York and in Buffalo has led to a simultaneous desire on our part to bring this matter up at once for deliberation. In order to have accurate information for the convention a letter was addressed to every manager of a central station in the United States, to the number of 800, requesting him to reply to the following questions:

Is there any one in your employ, or of your acquaintance, who has received powerful shocks of electricity from a dynamo-electric machine?

What was the nature of the current, continuous or alternating?

What was the electromotive force of the current of the machine in volts?

What was its capacity on full load in ampères?

What amount of current is supposed to have passed through the person?

At what points on his body were the contacts made with the electrodes?

Can you say which was the positive pole, *i. e.*, where did the current enter?

Was the shock a painful one?

What were the sensations?

What were the effects and how long did they last?

Please give as many details of the accident as you can.

If, now, electricity is to be used as a killing agent, it should be a certain agent. I will not go into the question of its mercifulness, because from the data which I will present, you will see that instead of being a merciful agent, it is the most cruel and dreadful one imaginable, and for that reason alone the law should be repealed. But aside from that, its uncertainty is the element that ought at once to condemn it as the means of public execution. I received from these 800 circulars several hundred answers They have been closely scanned. As time pressed, they were directed to the Executive Committee at Niagara Falls. I have during the last two nights, as closely as possible, perused their contents, and I have come to certain conclusions, which I will summarize briefly.

As some statistics of those I may say that I have received replies in which I estimate that there were 73 accidents that had happened in central stations. Of this 73, 19 were due to the alternating current, the balance, 54, to the continuous current. The questions that we asked bring out some very remarkable information, and I have this numerous list of answers collated here, open to members of the convention for inspection. I will read some of the remarks which show that the sensation produced by heavy currents not sufficient to cause death is dreadful and curiously diverse. No two people agreed as to the exact symptoms. For instance, it is declared that the action of the current upon one man was like cutting him in two with a buzz saw; another one says it was like striking him on the back of the neck with a sledge hammer; another, like knocking his brains out with a trip-hammer; another said that he felt himself full of needles: another, as if he had fallen from an immense height and had been dashed to pieces upon the ground; another, as if he had been smashed. So that altogether you will see that the effects are different in each individual, and all accompanied with the most dreadful sensations.

Now, if this law is put in force, it brings an obloquy upon our profession, and we will be bringing to bear upon the prisoner a punishment greater than any devised by the Spanish Inquisition. They had numerous and devilishly devised punishments, but there was nothing that simultaneously tortured every nerve of the body. They would put you upon the rack; draw you apart, limb from limb; put you on the horse; they would tie you by the thumbs; pluck out your eyes; but they never took every nerve in your body and put it upon the stretch at the same instant. Had they known what lies in these letters before me they would have gloated over execution by electricity as one of the most dreadful concoctions of the barbarous mind of a professional torturer.

Now, gentlemen, an effort has been made, and a persistent one, to fill the public mind with horror at the mention of the word electricity. When I see that citizens of New York and all of our large cities to-day fear to touch a wire; that they pass hastily under an arc light wire stretched across the street; that they feel, as I have been told, that when introducing an electric wire into a house they may at any moment come in contact with the same instrument that is to deal death upon a criminal; when the public are educated to this, I say that such a state of feeling will result disastrously to our interests.

There is still another thing that I would say; I do not see in this hall one face of one man who would venture to apply such a thing as an electric current for purposes of death. We are here for the purpose of advancing the uses of electricity, to make it rejuvenate the world, to carry it forward as a civilizing agent, not as an instrument of torture. I doubt whether there is in this broad country one reputable engineer—electrical engineer—who would deign to connect his name with the application of this death-dealing instrument to the purposes of public execution. Mr. Elbridge T. Gerry said that he had consulted physicians for the purpose of finding out whether prussic acid or morphine or strychnia or chloroform might not be used, and he met with the universal reply that not one physician could be found to administer any of these death-dealing agents. Shall we be placed in the position that one electrician can be found willing to administer our current for the death-dealing purpose? I deny that such a thing may be, and yet we hear that at this moment, while we are here in convention, there is one in the penitentiary in Auburn who is experimenting on animals, preparatory to the administering of that current to that criminal Kemmler. I say let us here vigorously condemn that action. It is impossible for any one, by experiments upon animals, to be able to say that what has been done with them can be done with equal effect on human beings. Let it not be trumpeted over this country that the dying groan of that criminal cursed electricity with its last sound.

But this thing is not a new thing—this effort to introduce electricity for the purpose of taking life. It was thought of from the very day of the discovery of the Leyden jar. The first man who discovered the Leyden jar did so by means of a violent shock, so violent that at the time he said he would not repeat it for the crown of France. It was very soon thought after that that electricity could be used for killing criminals, and so philanthropic a man as Benjamin Franklin (in this respect the equal of Mr. Gerry) tried experiments upon animals in order finally to be able to apply it to the killing of human beings. But he had a most unfortunate experience. Benjamin Franklin killed turkeys and fowls and dogs, and on one occasion after he had killed a turkey, in the excitement of the moment, he accidentally touched the conductors of the battery (two six-gallon Leyden jars) and received a shock himself, which he described as something terrible. You will see that my statement, that the pain attending the administration of electricity must be something most horrible, is corroborated by this. Benjamin Franklin was looking at his hand at the instant of the accident when he felt, as he describes it, throughout his whole body, "a universal blow." He was, in fact, knocked senseless. On his recovery he was told that the spot he was looking at at the time of the accident was where the current had entered his body. He examined his hand and found upon it a puncture and an elevation, as he describes it, the size of half a pistol bullet. He did not hear the sound of the discharge of the Leyden jars by which he was struck, although a bystander declared that it was as loud as the sound of a pistol; and though he had been struck by the spark which others had seen and which others had heard, he was neither conscious of it by sight nor by hearing, while he felt throughout his whole system this "universal blow."

Now, gentlemen, I think it will be impossible for us to determine what the amount of pain is that attends an execution by electricity. Those who have come back to us from the borderland that separated them from the eternal life have said that they have felt the tortures of the damned. And yet they recovered within a very short time, sometimes within a few hours. Now, what must be the agony that causes death? There is no one going to come back "from that bourne from whence no traveler returns" to tell us of his sensations. Let us judge by what we know when an explorer goes into a distant land, and on his way meets with such obstacles and dangers as to force him to return. Would we not be safe in surmising that greater dangers were beyond? Such is the case here. We find as a general experience of all those who have suffered from electric shocks of great intensity, that the pain is most intense; therefore, why should we not expect that the execution of an individual would be accompanied by still greater pain? The object of the philanthropist is to put him out of the world without pain. I have my doubts as to whether that is desirable, but if the lawgiver once states that his object is a philanthropic one, we may only discuss the question on that platform. I think that pain should, to a certain extent, accompany punishment. We pass slowly through life, and as we approach the final day, we find ourselves racked with pain. Nature provides that we should come in and go out of the world in pain, and why should these gentlemen, the philanthropists, say we must go out of it after having committed such crime as deserves death—why shall we go out of it painlessly? I think that is a most mistaken philanthropy. There must be a certain punishment attached to crime which will deter others from engaging in the same crime. But that is out of the province of the matter under discussion.

We have in the case before us a law upon our statute books which is a most obnoxious one. Fortunately for us, a man of talent in New York has, in a disinterested way, engaged himself as our champion, in order to delay the execution of the law. I think Mr. Bourke Cockran, of New York, deserves our hearty praise for the manly way in which he has opposed the hypotheses of some of the most brilliant names connected with electrical science. Gentlemen, now is the time for us to call the attention of the authorities to the iniquity of this law; as being a barbarous practice; and interfering seriously with a rising industry that some day or other is bound to be first in this world. Let them not nip it in the bud; let them not check this growth which has been so fair, financially. For these reasons I would offer a resolution which embodies the views I have expressed.

"WHEREAS, the law requiring the execution of criminals by electricity, enacted by the General Assembly of the State of New York, was enacted under a misapprehension of its philanthropic importance; and

WHEREAS, the National Electrical Light Association regards such a law as an unnecessary degradation of the most useful natural agent that science has ever rendered available for the service of man; be it

Resolved First, that the National Electric Light Association does hereby respectfully petition the General Assembly of the State of New York to repeal said law at its next session. Second, that in view of the inexpediency of said law, and until it is repealed, the Governor of the State of New York be requested to commute the sentences of all criminals condemned to be executed by electricity, to imprisonment for life. Third, that a copy of this preamble and resolution be forwarded at once by the Secretary of the Association to the Governor of the State of New York. Fourth, that the proper officers of this Association and that the Chairman of the Committee on State and Municipal Legislation forward a copy to each member of the General Assembly of the State of New York, at its next session, together with copies of such papers as the Committee may have at its disposal, urging the repeal of said law. (Loud applause.)

Mr. HUNTLEY: There is in our midst a gentleman who, by the papers this morning, has been assigned as assistant to Harold P. Brown—Dr. Fell, of Buffalo. I move that he be permitted to have something to say in this convention regarding this matter.

Dr. FELL: I was called to make some experiments at Buffalo with this powerful agent, with the view to deciding, when the question should come up, what was the best and speediest and most humane agent we could use in the execution of criminals. Now, gentlemen cannot we advance in this line as well as in others? From the demonstrations which I made, I could not help but come to the conclusion that there was no agent we had at our command which would execute criminals with such rapidity and without question of pain. I am satisfied that the experiments, so far as I am concerned, demonstrated that what could be done upon the lower animals could be done upon man. The question is, do we want to have the horrors of hanging kept up? We see it in newspaper reports all over the country every day. I feel that the use of electricity for the execution of criminals is not going to have the effect which you gentlemen think it will have. I do not see how the use of this great agent as the instrument of execution could affect the welfare of mankind and their progress in inventions I think that we will do away with the horrors attending execution, that the use of electricity will do away at once with this horrible condition of affairs. The accidental executions which have been taking place all over the land for some time demonstrate its success. I may not look at it from the same point of view that you do. I wish I could. If I thought for one instant that the use of electricity in the execution of criminals would retard electrical progress, I would say do not use it; but I say if it is an advance, then let us use it, and do not try and stop us from using it.

Mr. H. W. POPE: Does prussic acid require the use of a harness, the adjustment of apparatus? Does it require any preparations?

Dr. FELL: As to that, I do not think that electricity requires that.

Mr. POPE: It does; it requires a very careful preparation. Another thing, did not the Medico-Legal Society resolve that the use of any method in their practice would affect their interests?

Dr. FELL: As to that question, I would say that is merely the opinion of a body of men. Whether it would or would not, I cannot say. If it would, I should say do not use it.

Mr. MORRISON: Who do you think would be the best judges of the effect it would have upon the physician's practice, that body of men or some other body of men who did not use or knew nothing about it? The physicians gathered together, and decided, as Mr. Pope suggested, that the use of any method in their practice as a means of execution would be detrimental to them. I ask you what body of men would be best qualified to judge as to what would be injurious to the practice of their profession as physicians?

Dr. FELL: The physicians.

Mr. POPE: I would like to ask the gentleman, in reference to gas, Which has killed more people, gas or electricity? Is it not a fact that a week or two ago a new method for the destruction of animals was introduced in the city of New York, and that that was publicly mentioned in the papers as a more humane method of despatching dogs than the method heretofore prevailing?—that is, the introduction of gas in a sealed box, whereby they receive a painless death.

Dr. FELL: I can answer that, Mr. President, very readily. Possibly the use of gas, or any means of that kind to produce gas, is painful during the first inhalation—very painful, indeed, until a man is asphyxiated—until asphixiation takes place, and that gas would be more painful than electricity on account of the nerve current being so much less than the current of electricity.

Mr. F. A. WYMAN: Mr. President, I would like to say two or three words as a man. I had to talk as a lawyer before. Now to get down to business, I want to say to you, gentlemen, members of the National Electric Light Association, that if you have got a particle of spunk in you, it is time to bring it right out; but if you want to go down and have your whole association and profession—I call it a profession—killed financially, then you want to allow this execution to take place. I tell you you are scaring all the men, women and children in the United States by allowing this to go on. You are fixing it so that my wife does not dare to have it come into the house. I got her about ten or twelve years ago so she would allow a telephone to be put in, but you are fixing it so that I cannot have an electric light. These men who come in for the purpose of striking at one part of your trade,—you have got to stop that. I tell every manager of an electric light station here, every manager in the United States of America, who wants to increase the income from his station, that the time for him to put his force at work is now, and to try and stop this man from being killed. You cannot do it by passing resolutions, you can do it by personal appeals to your governor, which you must make if the courts decide that the law is constitutional. I do not believe they will. Then it is for you to go before the governor, not with resolutions, but send him carloads of delegates; go yourself, say, "Here, this strikes our pockets; it is the case of gas against electricity; it is the case of one man with one kind of current against another man with another kind of a current." And I say to you right now, be men. Do not fool around this any longer, but go there by carloads and lay right down on your governor so that he has got to commute that man's sentence.

Mr. Alexander showed how vague and inaccurate were the statements made as to the number and nature of deaths from electricity reported for a malicious purpose.

Mr. DE CAMP: I want to ask Dr. Fell as to his statement that several hundred persons had been killed—we will not question the number—and that they were killed instantaneously. That is the strength of his position, that particular point. That is the only evidence he has. He assumes that it can be done scientifically without pain.

Dr. FELL: And from my own observation.

Mr. DE CAMP: What evidence have you that these two or three hundred people were killed without pain? How do you get the knowledge?

Dr. Fell: I can answer that question. Helmholtz has demonstrated that the electric current passes—or Wheatstone has demonstrated it—at the rate of 280,000 miles per second of time. It has been demonstrated to the mind, and it is now accepted by physiologists, that the nerve current passes at the rate of 111 feet per second, or that it is 3,000 times less rapid than the electric current. Now, when the nerve current is that of sensation, when we pass the electric current through the body, is it possible for the nerve current to overtake it?

Mr. De Camp: I want to say I know of one man being killed, and he was killed unquestionably; but from all accounts I could get that man in being killed suffered very considerably. It was not a painless death that he received in that case. In all these cases—I am not going out of the particular range of cases you mention—death occurred under such peculiar circumstances that nobody, I think, is warranted in saying that this is any evidence whatever that these deaths by the electrical shock such as received and reported in the papers are painless. On the contrary, I think we have every evidence in favor of their being the opposite.

Mr. F. E. Degenhardt: I think these cries are due in great part to sudden fright. I refer to a case which came about in this way. Being in search of a gang of men at work in a basement, I walked into a dark place under the sidewalk and against a bunch of wires carrying a current of 210 volts. Immediately I struck the wires, I dropped to the ground and did not come to until fifteen minutes afterwards. I decided that I had been "scared to death." I believe that these cries are due to sudden fright. My experience in the matter was confirmed by the fact that a few days after I went into this locality and I handled this current without any difficulty at all. Possibly, a great many of these deaths can be traced to that action. In one case—Mr. Brown, of Chicago, will probably recall the case—a man was on a ladder and had hold of one support of a lamp. He reached out with his other hand, his foot slipped and he grasped the side of the lamp, and the man was shocked and dropped to the ground and broke his neck. There was no evidence that the current destroyed his life. His neck was absolutely broken. The man cried out for help. We were too remote to afford him that help, and the coroner's jury brought in the verdict that his neck was broken. I am satisfied that, from his long experience and knowledge of his business, it was a pure case of fright. He relaxed his hold when there was no necessity and dropped to the ground.

Prof. Anthony: I have only a word or two to say. In the first place, in regard to the velocity of electricity, Dr. Fell made the remark that it was well known that Wheatstone demonstrated that the velocity of electricity was 280,000 miles per second. All of us know that such experiments were unreliable, and that it is now perfectly well understood that it was not the velocity of electricity at all, but simply the time required for those wires to be charged, and for a spark to leap across the gap between the two wires. (Applause.) The velocity with which electricity passes over any given conductor is not known, and we know that that velocity depends upon a thousand things. In the first place, it depends upon the conductivity of the conductor; in the second place, upon the amount of pressure or potential; and upon many other things. The fact is that in the nerves of the human body the velocity of the electrical current is known to be immensely less than it is in a metallic wire. In a wet string, the velocity of the current in passing over even a space of a few feet is readily measureable, requiring quite a large fraction of a second to pass over a distance of even a few feet. I merely speak of this matter that it may go upon record, if these discussions are to be reported, that this question of the velocity of electricity cannot settle the point as to whether the death by electricity would be painless or not. I want to say a word in regard to another point. An execution of the death penalty, it seems to me, ought to be by some method that would not require experts. Now, is it possible, and is it likely, and will it ever be possible to have an electrical execution without bringing in electrical experts to prepare the apparatus and prepare all the paraphernalia, before the execution can be performed? Would any one not familiar with electrical apparatus be competent to adjust the apparatus, and make the necessary arrangements? Even after the execution had been performed successfully once, twice, or even ten times, by means of a given apparatus, would you then be willing to allow your sheriff at the next execution to put that apparatus in order, place the electrodes and touch the button which was to produce death? Would you find a sheriff anywhere in the State of New York that would be willing to take that responsibility upon himself? Could you find a sheriff who would be willing to fill this position? I doubt if after one hundred years have passed, electricity will be so understood by non-experts that they would be willing to take the responsibility of performing that act. Now I say that an execution ought to be performed in such a way that the men whose duty it is to perform it according to law, will be able to perform it without calling in two or three experts. (Applause.)

Mr. Morrison: Our business requires that we should state our objections to the use of electricity for executions; that these petitions should be divested of all flowers of rhetoric and all technicalities, and put in good plain straight English. I think that the case in hand ought to be treated from another standpoint, the standpoint of where this idea of executing criminals originated, and what was the motive of those who pressed it upon the government of the State of New York. So far as I have ascertained, it is not a question of dealing kindly with the men you are going to deprive of life. It was not that the criminal might die a painless death. It was not that a benefit should be conferred upon the people of this and of other countries. It was to enable an individual to advance his private interests and gratify his personal malice in pitting one system of electric lighting against another system. (Applause.) That is not a laudable ambition. Even if that gentleman should be elevated to the high rank of the executioner of Paris, I doubt if it would pay him for the contempt he will earn for himself from the men whose profession he soiled. I do not desire to touch upon the question which has been raised, and settled to their entire satisfaction by the medical and other scientific experts employed in this case. One point, however, in the statistics of our business as dealt with, and it will be found in the records of our association, and perhaps you will find here and there a page bristling with testimonials which will serve the purpose; that is, illustrating the little danger accompanying the use of electricity for any purpose whatever, whether it be for power or for anything else. A set of statistics was furnished recently which read something like this: So many men killed by falling off a scaffolding, and breaking their necks on the pavement; so many men by runaway horses; so many by explosions; so many by flies getting down their throats and choking them to death, and so many killed by electricity. And among the deaths quoted there is no business, and there is no business to-day conducted on a scale of equal magnitude with that of electricity, that presents so few fatal accidents. (Applause.)

I could enumerate case after case which would show that gas is more dangerous than anything else that you use in daily life. Everything that you use is dangerous; the food you eat, the whiskey you drink—or whatever it is you drink. (Laughter.) The water which you use, if improperly applied, is a death-dealing agent. Nobody would blame the bricks that the man is carrying up on the hod, if a man walking along three or four stories below happens to receive one upon his head and has his brains knocked out. A buzz saw does not make a very good seat for a man to sit down upon, but a man of sense will not sit down upon it. Electricity is not a good plaything, if it is used for arc lighting or for power, or for any of these commercial purposes; but if it is used with judgment, with the ordinary safeguards which experience has thrown about it, it is as harmless as that wood upon which I lay my hand. Now then, divest yourself of all fear of these things. Time will cure them all; and after the men who have attempted to throw discredit upon the business are gone and their names been forgotten, electricity will be looked upon as a friend and benefactor to man. Warmth, light, power, everything that is most desirable in man's life is furnished by this current which men are trying to persuade you now is so deadly. Our friends seem to lay particular stress upon the fact that the men who are advocating this execution business say that the current will kill a man. Of course it will kill a man. So will a hangman's rope kill a man; so will a big knife over in Paris. That knife will kill people; and I think that is about as painless a death as anything I know of—one whack and away goes the head, All these things bring you right here. We are dealing with an element which, if not properly held, will produce death. So will the ice which you buy in the streets. When you come to a question of painless death—a question of legal punishment divested of unusual or great measures, as the lawyer puts it—I ask you if this is a painless death, and one not surrounded by unusual and cruel measures, when you have a perfect theatrical arrangement around the place where the man is to be executed. The very chair that he sits in would almost scare a man to death; electrodes looking like Holman's liver pads put on each side of the head—everything calculated to terrify, to excite the worst fears, so that he would be glad for the pangs of death to come and relieve him from the fear of the tortures to be inflicted upon him.

This law is upon the statute books of New York. It is with you to-day, and it is incumbent upon the electric light men of New York to get rid of it. It is incumbent upon the members of the National Electric Light Association to do everything in their power to get rid of it. Do everything that you can do to open the eyes of the Governor of New York, so that the case may be presented to your next legislature, and enable this disgraceful law to be wiped from the statute books of a state which stands foremost in the civilization of this butt-end of the nineteenth century.

Mr. Morris doubted the wisdom of the proposed action of the association.

Mr. Duncan described an experience he had seen where the agony of shock had been intense.

Mr. M. D. Law: I will describe cases that occurred to me in the last ten years, and only two of a great number of them. I have been knocked insensible several times. One of these cases was one in which I opened a circuit, or the circuit was opened through me by the carelessness of one of my men, to a 700-volt current through my hands. I lay insensible at that time ten minutes, they say. The other most important case was one in which I shunted the current on a 60-light Brush machine through my hand. At that time my first realization of any sensation whatever was the watching of my hands. The first thing that came to my notice at all—I was drawn all out of shape—I was watching and wondering if my hands would ever come into position again. Gentlemen, I don't want to go through that experience again. The pain was torturous; it was terrible.

Mr. Lynch: I think it would be a great deal more fitting and courteous and bear a great deal more force if the association is to present the petition and resolution as presented by Dr. Moses, that they should be presented by a commitee of this association, and I would move that a committee be appointed by the chair for that purpose.

This motion was carried and the committee appointed later on.

The discussion on the central station papers, by Mr. Law and Messrs. Remington and Henthorn, was then taken up.

Mr. W. C. Kerr: I was very much interested in Mr. Henthorn's paper; unfortunately, I did not hear the other paper. I think Mr. Henthorn's paper was one of the best engineering papers ever brought before this convention. I would ask only one or two questions to bring out some points that are of interest in such a central station, which I think were not dwelt on in the paper. First, what provision is made, and just how is it made, for the heating of feed water? Second, what is done with the exhaust of the engine driving the condenser pumps, and whether that performs any function in feed water heating? and third, why was the plan of wheeling out the ashes in large ash pans on wheels used, instead of mechanical conveyors?

Mr. Henthorn: In answer to the gentleman's first question, I would say that the feed water, when running under regular conditions, will pass through the economizer on its way to the boilers, and in the event of making it necessary to shut out the economizer, the water will pass through to the boilers at a temperature, due to the overflow, which will be about 110 degrees. Then as to the cost of the steam from the condensing apparatus. That we have arranged so we can put it directly into the exhaust pipe, or directly into the cylinder of the engine. In other words, when they are running extraordinarily, the exhaust steam from the engine will pass directly into the reservoir between the intermediate cylinder and the last cylinder, the 33-inch cylinder. In regard to the matter of ash-pans, our only object in putting that in was that we thought we could handle it to a little better advantage and cheaper than by putting the conveyors in; that there would be less to take care of.

Mr. C. J. Field: In regard to the steam plants in these two stations, I think there is an opportunity here for us to get some data of comparison in regard to the relative and true economy of high-speed engines and low-speed engines. We have had one side of it laid before us in two papers, claiming every advantage that could be claimed for the slow-speed engine over the high-speed engine with single cylinders or compound, but we have not had an opportunity to hear from the other side, and as I happen to be engaged in trying to put in what I hope will be a good steam plant at an electric light station, I think it is an opportunity here to draw out some remark or some data as to where the true economy comes in. What we are trying to get is an electric light station that will be the best for earning dividends; we are not trying to spend the most money that can be spent on the plant, but trying to spend as much as will bring us the best returns. If we are going to spend two or three times as much for the same result to be obtained from one style of engine as we could obtain with another style, it comes down to a question of the relative steam economy of the two plants. We will grant the same boiler plant. Offset the difference in cost with the saving in steam economy, and I think you will find that it will be largely in favor of the high-speed, non-condensing or condensing. I do not think the cost of such a plant as that at Providence would be far from (including all the plant with its countershafting, etc.), $40 to $50 a horse power. You could put in, I know by experience, a compound high-speed plant 300 h. p. engine with good economy for a cost of about $15 a horse power. Now is that difference in cost to be made up by any saving? As far as I can figure, it is in favor of the high speed, and as far as general theory goes, I think it is in favor of high speed. As far as wear and tear is concerned, I think there is not much difference. But the reserve plant to be put in, on the other hand, must be taken into consideration. I would be glad to hear from some other gentlemen on this question.

Mr. Henthorn: I think we will have to concede to the gentleman that a slow-speed engine costs more money at the outset than a smaller engine, from the fact that you have to put more material in, and the builder must charge more money for that additional quantity, but at the same time there are other matters that we must look at outside of the question of first cost. There is the cost of running. This engine that we have at the station there has been guaranteed by the builders to develop a horse power for 12.6 pounds of water—12.6 pounds of dry steam evaporated or discharged from the condensing apparatus. If you have a station that takes about 1,000 h. p., 1 pound of water represents approximately $2,000 a year for every pound of water above 12.6 which represents 1 per cent. dividend on $2,000 capital. If you increase that up to what a high-speed engine would consume, or in the neighborhood of 17 pounds, possibly above it, there is a difference of about $10,000 in the running expenses. Of course the engine that we put in there cost about $40 a horse power. It is a three-cylinder engine designed so that we could attach a fourth cylinder back of what is known as the last cylinder. That of course would necessitate heavier frames and additional expense. It was done that way so that we could carry eventually 200 pounds of steam pressure, and all our pipe and boilers are made for that. As I say, the boilers and engine cost about $40 a horse power.

Mr. Field: May I ask if it is claimed that the engines will give that economy under a varying load, which we would have in any electric light station?

Mr. Henthorn: The guarantee covers a variation of 75 h. p.

Mr. Field: What are you going to get as the varying range which you will cover?

Mr. Henthorn: We have not tried that yet.

Mr. Field: I question what can be done. I know of a plant being laid out now with high speed and good boiler plant and economizers; it is expected to get down to 15 or 16 pounds. I think if you compare the cost of that plant with the cost of Mr. Henthorn's plant and give it full credit for economy under varying loads, that you will grant that compound high speed will carry the wear and tear under varying loads. In fact, builders are all willing to guarantee it.

Mr. Henthorn: There is no question at all that this engine of ours will require more than 12.6 pounds of water running on 100 h. p. It merely comes down to the matter of multiples. If you have an engine that you can run regularly—if you have business enough so that you can run nearly the uniform load, say 425 or 575 h. p. ten hours a day—we think it is policy to put in a first class economizer engine in such multiples as you have business for. That is, if your business requires multiples of 200 h. p., put in 200 h. p.; if 500 h. p., then put in 500 h. p. It is merely a multiple, that is all.

Mr. Field: Is your plant going to attain such results? Are you going to have such a load as that with such results?

Mr. Henthorn: I guess we shall come pretty close to it.

Mr. T. C. Smith.—I think this discussion is taking a very useful shape. I think we ought to look at the economical side as well as the engineering side. If you are using an engine that can run on 12.6 pounds of water, and a man up the street has an engine using 18 pounds, and if he can keep his lights going day and night without breaking down, he will lick you on your 12-pound engine every time, if you have a break-down once a month. I am an engineer myself, and am very much in favor of economy on the steam end of the plant. That is where the money is made and lost. Twelve pounds of water as against 18 is undoubtedly a great factor, and will pay a dividend if you can keep it up to that economy; but on that engine there are seven stuffing boxes, and piston rods to look after, and there are in the neighborhood of 50 or 60 steam joints and jackets and pockets and everything of that kind to keep tight, and 12 valves to leak. The engine that I am using and want to keep on using is a compound engine, guaranteed to take 18 pounds of water; it has one valve to do the whole business. It has no stuffing-boxes on it except one against the exhaust. It is internally lubricated, so that you use no oil except what is taken up by waste to oil the bearings. This engine can be run night and day, and the repairs are limited to using certain parts. Mr. Henthorn has enough to do to look after keeping his lights going without keeping an engine to look after. I think it will be a question whether you can get 12 pounds of water for six months. I think that after the engine has run four or five months, some day the engineer will have the valve out on the floor for a few minutes, when his other piston will break down, and before he can replace that valve and start up again he will damage his business more than he will save in water in ten years. I do not agree with Mr. Law that the compound condensing engine is the most economical. We want to build an electric light station for simplicity in the machinery and get rid of everything we can.

One point of Mr. Law's paper I would like to criticise. That is, the feature of his wires running from the dynamos to a switch-board under the floor. If he carries his wires through to the floor below and strings them along the ceil-

ing, then he has the best possible arrangement. I think for all ordinary purposes, however, they can be carried on glass insulators. It is a very bad plan in any station to have concealed high tension wires. You want them open where hose can be turned on in case of fire. If it is necessary to run a high tension wire through a building, run it on glass insulators, but if concealed, cover it with a box which can be taken off at any time.

The insurance of electric light stations is getting to be a very serious question. I have had on an average two insurance agents a week, and they always want to know where the wires are. They think that an electric light station is a very dangerous place. I tell them I think the packing box factory next door is more dangerous than our place is. The ordinary fire risks are the real dangers in electric light stations. I do not believe there are as many plants burned down by electricity as by accidents from matches and things of that kind.

Mr. M. D. LAW: That paper of mine was prepared in short order, and that point was overlooked in giving the description of the floor of the dynamo room. That floor should be left without any ceiling beneath it, and in our case was made of 2-inch plank across the joist, with a 1¼-inch floor laid diagonally across that. Our wires from our dynamos are carried through this floor in hard rubber tubing on the largest size porcelain insulators, on the lower side of the joist. Not only that, but it is the very best insulated wire we could possibly secure. That point in your dynamo room where the wire leads from the dynamos, and the wires on your switch-board, are the most dangerous elements that you have in the station. But, as Mr. Smith says, the dangers arising from the ordinary fire risks are very much greater in an electric light station than those from the electric light wires. One other feature should have been mentioned in the paper, and that is a means of extinguishing fire. You should always have a good fire pump easy of access, plenty of hose and plenty of fire buckets distributed about the place, and see that these fire buckets are kept filled. I nearly discharged one of my men very recently, who had charge of the fire buckets for not having his fire buckets in good condition. Having your men well drilled is another great feature in an electric light station.

Mr. KERR: Speaking of the dangers of fire from electric light stations, Mr. Law has suggested one thing which we do not have, that is, fire buckets. But we also have another thing that he does not seem to have, stand-pipes to work, with a reel of hose already attached, so that a man simply with a turn of his wrist has the water into the hose immediately. We do not have to stop to couple on the hose or put on the nozzle. Sometimes a nozzle may not be in its place and cannot be found. I shall also adopt the bucket.

A MEMBER: We do even better than that. Our hose is so arranged that when it is run off the reel it turns on the water automatically.

Mr. F. H. BALL: I want to ask Mr. Henthorn a question. I noticed that he mentioned that this engine is guaranteed to deliver power at 12.6 pounds of water. Are your pumps driven by the engines?

Mr. HENTHORN: Yes, sir.

Mr. BALL: Then, if that is so, a part of the power delivered by this engine is used for driving the pumps, and that much of the power is not available, so that this result that he speaks of running under these conditions, the 12.6 pounds, is deceptive. Part of this power is absorbed in driving your pumps. It is not available for lighting. Another point I would like to ask is, if he knows anything about the friction of this engine with its three cylinders, twelve valves and seven stuffing boxes and so on, and also of the line shafting. Can you give me any information on that?

Mr. HENTHORN: No, sir.

Mr. BALL: It is evident that there must be considerable friction there, and in all probability the load could not be constantly kept up to the capacity of the engine. Wherever they are running with a part of a load, in addition to the fact that the economy would be considerably less, I would imagine that this frictional resistance, being a constant matter—the friction of your pump, counter-shafting, etc.—I imagine that the economy of the engine would very much exceed 12.6 pounds. On the other hand, from an engineering standpoint, it would be very interesting to other managers to know what the consumption of coal would be per arc light per hour. These figures may be deceptive in regard to actual results.

Mr. KERR: The only criticism I would make of this ideal station, for it is certainly a model of engineering skill and a fine station, is that it seems to be so largely an end in itself—a monumental piece of engineering work, like Stewart's house in New York, but it may turn out to be an exceedingly desirable thing to build. If it does, so much more to the credit of the people who designed it and who built the machinery for it. An important question with that station would be its extension. We always have a lot of work in our business for posterity, but posterity never did anything for us, and when you begin to work for posterity, you begin to work on a very indefinite thing. We should work with an eye to an elastic station which can be extended. Build your station so that it can be extended in the future. The station which Mr. Henthorn has shown is an inelastic station, because it costs so much money that you cannot afford to change it. We know what changes have been made in electric light stations in the last few years, which have brought about an enormous improvement in electric light apparatus. Stations failing to make money at 100 to 200 volts in certain districts were able to pay on a 1,000-volt plant. But if they had to put in apparatus which occupied a different kind of floor space, the machines would not go in in the same way they did before. A good many things have to be refurnished, and in some stations it costs a great deal of money; in others, very little money. Now, the station which was the most elastic to begin with, could make these changes for putting in new electrical apparatus at a very low cost. Yet I do not believe the time has yet come, nor that it will come within the next ten years, when we can build electric light stations as they do water-works. The art is not far enough advanced. While I do not doubt that this is an excellent station which Mr. Henthorn has shown us, I would only criticise the general plan at all in that it is too expensive for the present state of the art. Electrical discoveries may be made very shortly which will seriously impair the utility of that station, and it would cost so much money to change that it never could be changed. That is the only objection I see to the use of it.

As to the question of striving for the lowest possible amount of steam economy, I have great doubt as to its utility. Steam engineering is not an exact science; so it is a very difficult thing for us to reason exactly what the ratio is between this economy of steam and some other plan of operation. We, however, do know, and it has occurred to me a great many times in the transaction of business, that, strange to say, the electric light plants that have made the most money are not the stations that have the most economical plants. It is a fact that the most economical plants have not produced the most money. If you go into the reason for that, you have to go so far that the reason becomes a little intangible, for the reason that men who have put in the lowest economy plants have paid more attention to some other branch of the business. I know of cases where 6,000 lights have been out in a single night in one city, where the results were extremely bad, where the loss could hardly be measured. There was certain important work going on which made the loss immeasurable. It sets them back in their business very seriously. I also know of a certain station, composed of about twelve engines, two of which were very fine 500 h. p. engines, high speed, simple type. The large engines in one year produced twelve stoppages of the plant which they drove, and the ten engines never had a stoppage against them. It is a notorious fact that any plant which ever stops its machinery gets a low rate at which to furnish its lights, and a plant that does not stop gets a high rate. Consequently the engineering of an electric light station must be considered from the standpoint of a good many things besides fine engineering. One of the best things about this station is the connections and general arrangement, the steam pipe, and traveling crane, and all those accessories, which are not materially more expensive than the ordinary way of doing things. I think it would be a great saving to stations if they would adopt better methods of connecting apparatus, and paying more attention to how they put pipes together, and so on. How many times we have had a station shut down a whole night by an improper steam pipe! That is just as important as selecting a good engine, or getting the boilers to evaporate a large amount of water to the pound.

STANDARDIZING POTENTIAL FOR ELECTRIC RAILWAYS.

Mr. LYNCH: I would like to make a remark. I don't know whether it comes under the head of this engine business, but it certainly comes under the business of the association. I have been very much astonished to know that notwithstanding the number of persons engaged in the electric street railway business, none of the companies seem to be receiving current from the local electrical companies. A great many reasons have occurred to me why it might be arranged so that the electrical companies could supply current to the street railways. There seems to be a unity or consolidation of interest between these people, and I have thought there was great danger in the future of these street railway companies, by improved engines and motors, having stations in the centre of cities, establishing a system of motor business which would interfere very seriously with the electric light business. The great trouble is that there has been no standard of electromotive force used by the railways. One company uses 400 volts, another 415, another 450, and another 500. It is simply a question of what the inventor would like to use. The difference between 450 and 500 volts is so small that there is nothing in it. The electric light people have not wanted to supply these companies because they would have to buy different apparatus for every railway. It is not interchangeable. If four or five different railways came along I would have to have four or five different sets of apparatus, but if we could have a standard of electromotive force, and four or five sets of large machines, we could supply a dozen railways from a station. This power is required during the daytime when the electric light station is to a certain extent idle. It is a business that I would like to take up very much, and I have drawn up the following resolution:

WHEREAS, It is the belief of the members of this association that the electric motor service upon street railways will require a service of electric current for the motor that will be reliable and constant, and that the various electric light stations are capable of generating and distributing such current,

Resolved, That a committee of three be appointed by the President who shall endeavor to make such arrangements with the manufacturing companies, that they should adopt some standard potential to be used upon the various railways. The committee also to collect such data regarding the supply of current to railways as may be deemed of interest to the association.

A MEMBER: I do not know of any people building or running electric railways who have not a complete system of their own, and they would not permit you to suggest to them the use of any other system.

Mr. LYNCH: It is not the use of any other system; it is simply asking them to use a standard potential, so that a man with a 100 volts or 500 volts could supply a railway operated with either system.

Mr. MORRISON: But the man who owns the railway won't let you.

Mr. LYNCH: The street railway people know absolutely nothing about electricity. They go to the electric lighting man and say: "Will you supply us current?" He says he will not. I think it would be a move in the right direction to standardize the apparatus to be used by central station men, if they can make any business of that kind with street railway concerns. It is simply standardizing the potential of the street railway system, if that can possibly be done; they are not far apart at the present time. It is only the difference between 400 and 500 volts.

Mr. SMITH: I have had occasion, Mr. President, to inquire into this question a little with regard to the supply of current to street railways from electric light stations, and I found in nearly every case it has been purely a question of cost. The railroad people say electric light men want too much, and the electric light company says: "We do not propose to invest a lot of money in apparatus and tear our stations to pieces unless we get a good price." I think that Mr. Lynch has made one very good point. The difference now existing is very small, and I am satisfied in my own case they could secure contracts could they assure the street railway company that for so much a year they could rent power, instead of having to put in a new staff of engineers and firemen and a lot of people of whom they know nothing.

The PRESIDENT: The progress made in this direction would be slow, and encounter a good many obstacles. I still think the tendency of the time is toward standardizing. We can remember when railways were built with all sorts of gauges. We now have them of standard gauge, and all of us who are in the business know what a multiplicity of differences we have, how difficult it is for a man who has had his service from one system to get service from another system. He has to go to the expense of changing a good many things. There has been some talk abroad on this same topic, and I think some good will come in the way suggested by Mr. Lynch. I know we will have the interests of the manufacturing companies to contend with, as each one is striving to give somebody something that he will have to renew only through him; their interests are all in that direction, but it is only a question of time, gentlemen, before these things must disappear. They must come to a certain standard, which will be the result of the experience of all, and will be dictated by economy. It seems to me that the resolution offered by Mr. Lynch is in the right direction, and while, as I say, I think the progress of this committee must necessarily be slow, as the work is arduous, I think it should be put through.

Mr. MORRISON: I do not think the committee will accomplish anything. That is the only reason I object to it.

Mr. SMITH: This thing is one that you can bring home to the electric light companies, and electric companies generally, with some pretty forcible arguments. One is, that in one city I saw a report recently, that a street railway, as a part of the conditions on which they were permitted to change from horses to electric cars, agreed to put an arc light on every corner. They went to rent those lights from the electric light company, who had an exclusive franchise, and found it would cost 60 cents a light. They put in a dynamo and found it cost 14 cents. How long is it to be before they are running lights and renting them to consumers along the line? Just as soon as they find they can do it successfully, they will sell light. I suggest that on the standardizing of these machines you could appeal to the manufacturer also. When a man is running an arc light system, using 10 ampères, and another man comes along and tries to sell a dynamo that takes 20 ampères, the first result is that there must be a whole new set of lamps. But another man has a 10 ampère system, and he says, "You can put my lamps on your dynamo, my dynamo on your lamps." If the manufacturing companies object to the standardizing, it is because it would enable them to knock some other fellow out. I hope the resolution will go through.

The PRESIDENT: You want to suggest that it will give them a wider market for their apparatus. Recently a company was formed to develop a certain district adjacent to our city. They came to me to know if I could give them power. They had not money enough to buy the whole plant, but they had money enough to lay the track and equip the line. I could not give them power for the reasons stated by Mr. Lynch and Mr. Smith, and the result was that the manufacturers did not sell them the motors and the other appliances.

Mr. W. C. KERR: I would call attention to the fact that standardizing is not uncommon, since by it certain machines could be duplicated by others. Engine builders use the same standards of nuts, bolts and threads. Take a thing from one engine and it will always fit another engine.

Mr. LYNCH: I think the overhead wire problem is coming to electric light people in almost every city and town in the United States. Street railways are already being put up by that system, with a double line of poles on each side of the street. If there could be any arrangement by which the electric light companies could co-operate with the railway companies, it would simply save the electrical companies from the underground troubles. You have got to have the street railways; it is really a necessity, but people say they can get along without the electric light.

The PRESIDENT put the motion of Mr. Lynch on the resolution to vote, and it was carried. The Chair appointed Mr. Lynch as chairman of that committee, and as the other members, Mr. T. C. Smith and Mr. M. J. Perry.

Mr. MORRISON moved that a committee of five be appointed to present nominations to the convention for officers of the executive committee, and to suggest a place of meeting for the next convention. Carried.

Mr. S. M. YOUNG then read a paper by Mr. Wm. Bracken, on

ELECTRIC TRACTION BY STORAGE BATTERIES.

I have been invited to address you on the subject of electric traction by storage batteries.

It has been customary for speakers on storage batteries to begin their discourse by apologizing for their subject. That day has gone by. The storage battery has no longer any apologies to make.

My purpose at first was to give a detailed account of the progress of storage battery traction, by going back to 1881, when the first storage battery car was run, and following up the history of improvements from that time to the present. But I have found it impossible to get full and reliable data as to the work accomplished in Paris, in England, or in this country. I wrote to almost all the companies and individuals who have been engaged, or are now engaged, in storage battery traction to send me full accounts of their experiments and work; but I regret to say that only one responded to my request, and that was Mr. A. H. Bauer, who gave me a very interesting account of his experiments with his storage battery car in Baltimore, in 1885-86. The published accounts of the operation and experiments of storage battery cars in Europe are so obviously inaccurate as to be unworthy of reproduction. There is one exception, however, to this, and that is, the account given by the jury of commissioners at the Antwerp Exhibition of 1885 on the work of the storage battery car exhibited there; but as you are all more or less familiar with that report, I will make no further reference to it. I am, therefore, compelled to confine my remarks to my own observation of storage battery traction. I will not weary you with threadbare information. I once heard a judge tell a loquacious lawyer that he must assume the court knew *some* law. I will assume that you have a pretty general acquaintance with the storage battery in lighting and in traction; but there may be some features, chiefly commercial, that have not come under your observation. My observations cover a period of over three years, during which time the company with which I am associated has directed its talents and energy to the development of storage battery traction. You all, no doubt, appreciate the difficulty of the task—not alone difficulties inherent in the system itself, but difficulties arising from the skepticism and lack of sympathy, I regret to say, of a very large majority of the electric community. We all know how much skepticism on the party of street railway men has had to be overcome in electric traction of every kind. It has taken a great deal of hard work—of missionary work—on the part of electrical engineers and inventors to bring about present results. But this is not to be wondered at; for there is nothing harder to accomplish than to supersede an old and well-established system. The horse car had plodded along and gathered strength and influence just as it had gathered fares. That influence was wide spread, and almost all-pervading; for there is hardly a town on this great continent that has not its horse

car line. The horse car system had been spreading for about fifty years, and when it came to be in full and undisputed possession of the field, can it be wondered that those men who had the hardihood to attempt to supersede it should be regarded with more or less suspicion—should be looked upon as pretenders—especially when you consider that the method which they propose to employ was electricity!—that dark and mysterious science, as many people, even now, regard it.

Now, the first experiments made with electric cars were calculated to increase this suspicion, and to throw disfavor on electric traction; for it is a characteristic of inventors to be so far carried away by their enthusiasm as to commit great indiscretions in carrying on experiments in public which really should be conducted in private. It was on this account that the early experiments of Daft, in 1883, and of other well-known electrical engineers in succeeding years, while they created wonder, did not beget confidence. I may say, without any invidiousness, that two years ago there was not a single electric car run in this country that proved anything more than possibilities.

There were probably two dozen cars being run at that time by the overhead wire system, but so unsatisfactorily that people who went to see them came away shaking their heads with distrust. Now all this distrust has disappeared, and electric traction has grown so fast that to day there are no less than one hundred street car lines in this country that are either running their cars by electricity, or are in the course of introducing the system. Electric traction has beyond all doubt come to stay; as the French say, it has arrived. But the large cities are threatened with the cable. The storage battery proposes to challenge its supremacy.

There is a very general popular misconception of the nature of the storage battery. I suppose that at least 90 per cent. of the public have an idea that storage batteries are nothing but buckets, full of electricity. We read in the newspapers, from time to time, of storage battery cars carrying "tin tanks" filled with electricity. There can be no greater misconception of the nature of the storage battery. The clearest idea I can give you of the energy contained in a storage battery is to compare it with a lump of coal. The source of energy in a battery is identical with that contained in coal. It is merely energy locked up in a number of substances, principally the metals, which, when set free in a certain manner, manifests itself in a certain phenomon we call an electric current The metal almost universally used in the storage battery is lead in its various forms. In this lead is contained latent energy, the same as in coal, and if we compare the amount of work accomplished by the energy from either source in foot pounds, we will find it to be exactly equal in both cases. Now the general principles involved in a storage battery are very simple. When we charge a battery from a dynamo or other external source of electricity, we are manufacturing lead, and when we discharge a battery through an electric motor or series of lamps we are simply burning lead. But there is this difference between the action of coal and lead, that whereas coal apparently disappears when burnt the lead does not, but is converted into sulphate of lead to be converted back to metallic lead again by a reversal of the current, so that the storage battery is alternately burning and reducing lead to and from one of its salts. This is why the storage battery lasts and does not disappear in the extraction of the energy, as coal apparently does. In fact, the storage battery is an ideal illustration of the conservation of force and the indestructibility of matter.

When the storage battery first became known in a practical and commercial form by the experiments of Planté in 1859, scientists foresaw for it a great future, and when corporations were formed later on to exploit and introduce the storage battery, the people of Europe, influenced by what might have been considered the extravagant praises of Sir Wm. Thomson and other well known scientists, put an enormous amount of capital into storage battery enterprises. Almost all of those enterprises, however, proved to be commercial failures; first, because the exploiters were ahead of their time; and, secondly, because the public were led to expect more than the storage battery in its then crude form would do.

There probably have been few things more difficult to accomplish than to bring the storage battery to its present stage of commercial value. Notwithstanding all that had been written about its nature and characteristics, its treatment, both in its manufacture and use, has, until very recently, been purely empirical. That stage, fortunately, has been passed; so that, with intelligent care, the storage battery to-day is not only a valuable adjunct in lighting, but is becoming a very prominent factor in traction.

The advantages of storage battery traction, assuming that it is practical and economical, are too obvious for me to occupy your time in recounting.

The obstacles in the way of the success of the system are largely, if not wholly, overcome. The chief of these was the *handling* of the batteries. That was the most difficult and the last obstacle to be overcome. Two improvements removed these difficulties. First, the *flexible connector*, by which it is possible to couple up or remove cells with great rapidity; and secondly, the battery rack, occupying a floor space of 24 × 7 feet on each side of the car, wherein can be stored a sufficient number of batteries to run from 10 to 30 cars, according to its location. This rack represents stall room for 150 horses, or say 6,000 square feet. I regard this rack as the greatest improvement hitherto made in storage battery traction. By its aid we remove the batteries from a car, and replace them by another set in from two to three minutes. Indeed, our cars on Madison avenue, New York, have to leave the station on six minutes' headway. In the afternoon trips there is but six minutes' interval between their arrival and departure; and they all receive their batteries from the same rack. When the car enters this rack, its panels are dropped down on either side and thus form bridges over which the batteries are withdrawn from, and replaced in, the car. While this change is being made, a competent person inspects the regulators of the car. The motors, gearing, and connections are only inspected once a day, and that at the end of the day's work. You will thus perceive that the great bug-bear of how to store the batteries is no longer an element in storage battery traction.

From my observation of the recent work on Fourth and Madison avenues, now that a number of cars are running, and under very unfavorable conditions as to station room and the like, I am led to believe that the storage battery car is as free if not freer, from accident, as cars that are run by the overhead system. The motors are, I think, subjected to less trying conditions, owing to the fact that the E. M. F. is always uniform. The batteries never give out on the trip. It is impossible for them to do so, as they leave the station with thirty-five electrical horse-power hours stored in them, and do not consume quite twelve in the round trip of 12 miles. The battery in service has never been short-circuited. When the current required exceeds 150 amperes, the battery is automatically cut out. When rigid connectors were used, breaking was frequent, and the flexible connector has, until recently, given some trouble from time to time by jumping out of position while the car is in service; but with recent improvements, disconnection of the batteries while the car is in service is now rendered almost impossible. For several months past the regulators have caused absolutely no trouble. In any event there are two on the car, so that if one should fail the car may be operated from the other end. You will thus perceive that the likelihood of accidents or breakdown is reduced to a minimum. The first standard car has run in three months over 6,000 miles and carried over 80,000 passengers, never having missed but one-half a trip in that time, and that arose from a bent axle. It has never had an accident or stoppage of any kind while in service. Do not be skeptical at the assertion when I tell you that not a dollar has been spent on that car in the way of repairs or alterations.

At this stage you will naturally ask, How about the life of the battery? I answer that, from our observation, there is nothing to fear on that score. A life of six months from the positive plates is sufficient; it is found that they will last very much longer than that. The chief reasons why the short-livedness of a storage battery has been so much talked about and feared, is that it has, until recently, cost so much to manufacture the battery. Now, the material for your battery you have to buy, in a great measure, but once, for the reason that the discarded battery can be made over new. The raw material in two sets of battery, capable of running a car 120 miles a day, costs, exclusive of the containing jars, about $300. Have you machinery and devices requisite for manufacturing this raw material cheaply into a battery? If you have, you need have nothing to fear on the score of economy. It will cost $1,000 to purchase enough horses to run a 16 foot car 120 miles a day; it will cost about $1,500 to purchase enough battery to do that work. The batteries can be maintained for about one-half what it costs to maintain the horses; and by maintaining, I mean replacements as well as feed. This I know for a fact. Can we then have any further doubt as to the relative economy of storage battery traction?

The cars on the Madison and Fourth avenue line take one electrical horse-power hour per mile. The road has some long gradients. The grade at Centre street is over 4½ per cent., and 600 feet in length.

The cost of motive power for a car-day of 75 miles we estimate at $3.40, as against $7.50 for horses. Five dollars for 75 miles ought to cover the cost in winter. By motive power we mean the cost of energy at two cents per horse-power hour, and $700 per annum for maintenance of batteries and motors. To those who may think that two cents per horse-power hour is a low estimate, it may be said that power has been offered in New York, to be delivered at our station, at the price above named. In towns outside of New York, offers have been made to supply current at lower figures. The more level the road, the cheaper obviously will be the cost of motive power. This is more particularly true of the storage battery, which in excessively steep and long grades becomes heated. The chemical energy, instead of exhibiting itself in the form of electrical energy, exhibits itself in the form of heat, with consequent injury to the battery. Cars will ascend very steep grades; but it is not deemed economical to attempt grades of more than 6 per cent., and they must be short at that rate. But there are few roads offering more and steeper grades than the road we are now operating on in New York. Each car has two sets of battery. A set is easily charged in about two-thirds of the time the other is in service. No time is lost in charging, as the battery is automatically put in circuit with the dynamo as soon as it is withdrawn from the car. Now that there is a complete group of cars in service in New York; it is hoped to follow those by another group of ten. More will be known about storage battery traction at our next annual meeting.

The president then announced the following committee to nominate the Executive Committee and to choose a place for the next convention: Chairman, J. F. Morrison, E. T. Lynch, Jr., C. C. Martin, E. F. Peck and A. J. DeCamp.

The convention then adjourned, to meet at seven o'clock in the evening.

EVENING SESSION.

The convention was called to order by the president at 7:30 o'clock, and then adjourned until 9:30 A. M. of the following day.

THURSDAY MORNING SESSION.

The convention was called to order by the president at 9:30 o'clock.

Mr. A. R. Foote: In presenting the report of the Committee on Legislation I have written what may be called a summary of the steps taken to organize that committee. In doing that work a certain number of circulars were used, copies of which I have here, and they are exhibited as a part of the report. With the permission of the convention I will omit reading those, as most of them have been printed in the electrical journals. They are only attached to the report to have them brought in properly as a part of the business of the convention. If there is no objection I will read that part which is new to you.

After reading the first portion of the paper, Mr. Foote said: That is the second part of the report. The committee held a meeting yesterday morning, and as a result of this deliberation submit the following as a plan of work.

Mr. Foote then read the second portion of the report submitting the plan, which has already appeared. The report also mentioned by name some states in which electrical legislation has been brought up.

Mr. Foote, in conclusion, said: That plan of work is submitted to the convention for its action. In addition to that, the committee adopted the resolutions read by Dr. Moses yesterday on the subject of electrical execution. That subject coming up before the report of the committee, I thought it best to hand the resolutions to Dr. Moses, that they might be brought in and acted upon in connection with his address. This, gentlemen, is the report of the committee.

The report was received and filed.

Mr. Pope: Mr. Chairman, I think this matter of the legislative committee should not be passed over so lightly. It is to us in New Jersey a most important committee. That is to say, every winter we meet with legislative strikes. Last winter it was with difficulty that we overcame very adverse legislation, and we had in mind the forming of a State committee for the purpose of carrying on that work after we appreciated that every year we would be in worse circumstances. Now, we have incurred some expense. I would like to ask the president if the finances of the association would admit of our making any expenditures at all in connection with this matter. It is almost impossible for us to do it now, as I understand it. We have got to have an attorney in these different States and must go to some expense, else the efforts of the committee will not amount to anything.

Mr. De Camp: Mr. Chairman, on that point it has been manifest to the committee of which I have the honor to be a member, that a general committee is necessary in order that one State should get the benefit of what is done, or known to be done, in another State. The organization of State committees has suggested itself as being the best way of accomplishing that result. But in order to get that information and have it disseminated over the country so that the State of Ohio can have the advantage of the information, and have it in a shape in which they can use it, we have got to have a general committee, because we are all aware that the legislation in one State is very largely shaped upon what is done in another State. There is no legislature or committee of legislature which would be able to deal alone with the question. The State committees of the different parties shape that legislation in their own State, and they only can do it. I do not see that this association can make any rapid progress in that direction, and in answer to Mr. Pope I would say that that thing has been already blocked out by this committee. It is a pretty big work, and whether it will be gotten into shape by the next meeting is a question. It is too big a work; it will probably take a year or two to get that into right good shape, but I believe it will be very effective when it is put through.

Mr. Pope: I feel very much in the matter, because we will not meet again probably until the legislatures meet in the various States, especially in our State, and we feel the necessity of getting right at work in the matter. We are close to New York, and feel the effect of all this New York legislation, and there is a continual cry there against overhead wires.

Mr. Rhodes: The question has been asked about the finances of the association, and whether they would permit the appropriation of a certain amount of funds for the purpose of this committee. I would like to say, to anticipate in part the report of the committee which will be presented this afternoon, that the finances of the association are in much better shape than they were six months ago. When this executive committee came into power, there was a large indebtedness—comparatively large for this asssociation. During these six months the whole indebtedness has been paid and the association is now out of debt, with a balance of cash in the treasurer's hands. There will be to pay during the next few days a certain amount for the expenses of this convention and the printing of these proceedings, which will cost much more than the proceedings of any other convention that has ever been held, because they will cover more pages. The association is financially in a solid condition at present, but the treasury is not in such shape that it will permit any large drafts, and I sincerely hope that no resolution appropriating funds to any purpose whatever will be passed at this convention, or if any such appropriation is contemplated, that it will not be made without first being referred to the Executive Committee, to the Treasurer, or to the Finance Committee, which is a sub-committee of that Executive Committee, for their consideration and report. It seems to me necessary that the finances of the association should be kept in good condition, and not suffered to be relegated to the position in which they were six months ago.

Mr. De Camp: It has been the practice of this association to make an appropriation for everything outside of its general committee. Now, if Mr. Pope forms the State association, and I propose to make that effort in the State of Pennsylvania, that committee will have to do its own work. The general committee can only help them by furnishing such information as they have been able to collect from the other States, and that is the committee to bear the expense of that particular legislation. I do not think it will be a very burdensome expense; at least, that committee can do its work very much more cheaply than the general committee can do it. After that committee gets to work, the legitimate current expenses of the general committee will be about all that this association will be able to appropriate—if they are able to appropriate anything. It may occur to some that if these State associations are formed, and they do their own work and pay their own expenses, they have no interest in the general committee, but they have. The compensation that they will get from that will be a very considerable one. In this shape the State committee could accomplish more in one day than could otherwise be accomplished in six months, because the general committee will have it in just such shape as they want.

Mr. Leonard: I would like to ask Mr. Foote if there has not already been some expense incurred in the work of this committee?

Mr. Foote: In answer to that question I will have to say that there has been some expense incurred. I incurred it entirely on my own responsibility, as I have never had authority to spend any of the money of the association. The amount of money I have expended for printing for the committee is about $95, for which I have shown a receipted bill to the members of the committee.

Mr. Leonard: Then, it seems to me, that the least the convention could do would be to reimburse Mr. Foote. If there are no funds to make any further appropriations, it hardly seems the proper thing to ask Mr. Foote to carry on this work and pay out of his own pocket for something that we expect to reap the benefit from.

Mr. Rhodes: Possibly my statement has been a little misunderstood. I suggested, and I am sure I represent the opinion of every member of the Executive Committee on that point, that no appropriation should be made in this convention in session assembled without being referred to the Executive Committee. I understand that this committee has been at some expense for printing. I do not think that the account should be thrown out, but I do think that it should be referred to the Executive Committee for their report, simply because it will furnish a precedent. If these accounts are referred to the Executive Committee, I have not the slightest doubt that the President of the Executive Committee would pay such an account as that, but I believe the proper course is to have it so referred, or refer it to the Treasurer or Finance Committee to know whether the treasury will support it.

Mr. De Camp: Mr. Chairman, I would move that the chairman of that committee render his accounts, and that the same be referred to the Executive Committee.

Mr. Rhodes seconded the motion.

Mr. Lynch: Mr. Chairman, I think this is straying away from the point we started out on. I think the most important question is not whether we will go to any expense in providing legal talent in the various States or for each committee, nor whether we shall pay Mr. Foote's bill or not; but the important question is, what shall we pay in the future? I think Mr. Foote should submit to the association some of the items showing the expenses.

Mr. Whipple: Perhaps I can assist the association in this matter, I am connected with a street railway company in the West which has reports of all the laws upon the statute books in every State, and I am willing to offer that to the association free of cost. Within a very short period of time I will be able to present to the association the complete laws upon the statute books of every State in the Union. I have the work very nearly done now, and at an expenditure of something like $2,000. It will certainly cost the association $2,000 to get that information.

The PRESIDENT: The question is on Mr. De Camp's motion to refer the account to the Executive Committee.

This motion, being duly seconded, was put by the president and carried.

Mr. LYNCH: I move that the chairman of the committee be requested to submit to the association, or to members of the Executive Committee, a statement giving in detail the expenses that he thinks this committee would incur in the future.

The PRESIDENT: I might say in this connection, gentlemen, that this committee has done a great deal of work at considerable expense, all of which we appreciate. But this work has been added upon by Mr. Foote and his colleagues, actuated by motives of good for the association, and with the distinct and clear understanding that the work should be done without expense to the association. If there is no further discussion on this topic, it will now be passed.

Mr. MORRISON: One remark. Mr. Foote does not ask you for any pay. The suggestion of Mr. Lynch covers a point that Mr. Foote cannot answer. He is engaged in a work that covers a great deal of ground. He could not make an estimate of the expense of such work. He has not asked you for anything. He has made no proposition to present a bill to the association. They have asked him to present a bill of the expenses to be referred to the Executive Committee, and I have no doubt that he will do it. The association has never been niggardly in my experience. They have paid claims of members from time to time without any question. I think at this time this business is entirely out of order.

Mr. LYNCH: I think that I have been misunderstood. It was only my desire to facilitate the movements of Mr. Foote's committee. I will withdraw my motion.

The PRESIDENT: Is Mr. Rhodes ready to report for the Executive Committee? We will first hear from the Secretary a communication from Mr. Steuart, Chairman of the Committee on Patent Legislation.

The SECRETARY: Mr. President and gentlemen, I have the following letter:

BALTIMORE, Aug. 5, 1889.

Allan V. Garratt, Esq., Niagara Falls, N. Y.

DEAR SIR: I have your favor of some days since, and am sorry to say I will be unable to be with you at the convention at Niagara. My partner is away, and I am so busy that I will be unable to leave.

Please say to the convention for me that the plans of the Legal Committee are all in shape, to begin operations upon the Fifty-first Congress as soon as it convenes. Judge Culberson, who was Chairman of the Judiciary Committee of the last session, I am told, will be upon the same committee during the coming winter, and out of courtesy to him our bill will be taken up among the very first acted upon and his previous report adopted. I hope we may be able to induce him and the other members of the committee to recommend the passage of the bill as it was originally filed, providing for five judges instead of three, as recommended by the committee report of last year. There is every reason to suppose that we will have little trouble in passing the bill in the Fifty-first Congress, and if we succeed, the National Electric Light Association may congratulate itself upon having achieved a very great reform in the patent system of the United States. The work of this committee during the next six months will have my best efforts, and I feel very sanguine of success.

Very truly yours, ARTHUR STEUART.

This communication was received and ordered to be spread upon the minutes.

The PRESIDENT: We will now hear from Mr. C. C. Haskins, City Electrician, of Chicago.

Mr. C. C. Haskins then read the following paper on

DYNAMO ROOM ACCESSORIES FOR INTENSITY, POTENTIAL AND RESISTANCE MEASUREMENTS.

The investigator who expects to find a steam plant running without a water and a steam gauge at the present day will reckon without his host, and in very many instances he will find also a tell-tale pressure gauge in the office of the manager, who can turn at any moment, without moving from his desk, and see as well as if he took a run over to the engine room, what pressure the boiler is carrying. It was not so in the days of Boulton and Watt, but the fact that those worthy representatives of the past were without such modern appliances has not kept these from becoming honored occupants of the engine room of to-day. Progress is near akin to that mother of invention, of whom we so often hear, and progress just now calls for more and better appliances for the improvements of our methods of producing and the handling of that boundless and wonderful energy which we call electricity. We have advanced far enough to see that economy in production is essential, and we are now learning that having once developed that energy, the old and homely adage of Franklin, "Waste not, want not," is as applicable to electric economy as to matters of merchandising or the cultivation of the soil.

While the inventor is striving, and with reasonable success, too, to lessen the fuel expense, and the wear and tear is being looked after by the constructor, we may ask, Is the operator keeping his end of the burden level by a proper attention to the means within his reach for aiding in the general economy? That the inventor has assiduously labored at his part of the task is abundantly shown by

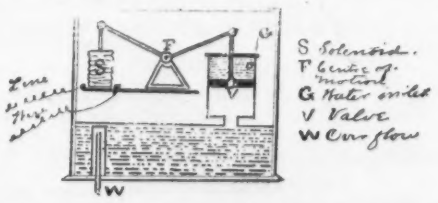


FIG. 1.—HASKINS ON STATION MEASURING INSTRUMENTS.

the records. There are meters and meters. Ingenious meters, and almost judicious meters. No sooner was it seen that a necessity had arisen for something by which to measure currents, than men of inventive ability and men without, nearly tumbled over each other in their haste to reach the front, and present their various claims. A look at a few of these may not be uninteresting. I have not endeavored to classify the following, nor do I claim to have gathered all there are in existence. To many of these there are several claimants, and I have quite generally adopted the rule of mentioning no names, a safe method, perhaps, of keeping out of the muddle which sometimes arises from a trifle of jealousy, and leaving the ownership to be decided by others. My object is to cite the apparatus, not the inventor.

Gravier, in 1880, suggested that with a given carbon, the current consumed would bear a direct ratio to the amount of light given. He supported his statement by mathematical calculations and comparative tests by other methods. This was ampère measuring by photometry. In the same year Marcel Deprez and Siemens and Halske brought out nearly parallel inventions. In the former, a long coil is placed parallel to, and between the legs of a horizontal horseshoe magnet, extending from the neutral point to the poles. This coil is so adjusted as to revolve, like a shaft at right angles to its length, being delicately supported at either end. An index attached to the shaft is made to act as a scale beam, and a sliding weight restores it to zero. This form of galvanometric weighing differed principally from Siemens and Halske's invention in that the latter was a vertical arrangement of coil and magnet. Becquerel and Joule had also accomplished much the same result before then. Hopkinson's voltmeter had two parallel wires, through one of which the current was passed. To one of these an index was attached, the other being

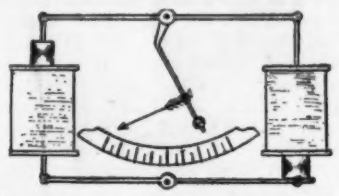


FIG. 2.—HASKINS ON STATION MEASURING INSTRUMENTS.

part of a graduated arc. The dilitation of the wires by normal heat moving both index and scale in the same direction kept the indicator at zero, so that when a current traversed the second wire there was no error due to normal temperature to be corrected. Heat in this case was the measure of pressure. Siemens and Halske, among other inventions, exhibited one of a still different form. In this, there is a combination of solenoids and clock-work, with a registering disc.

A very radical departure was made by an English inventor, who is well known in electric lighting. In the system which he patented, a lever at one extremity terminated in a solenoid core, while at the other extremity of the lever was a plunger valve. When the current passed through the coils of the solenoid, the core was sucked in, the valve was opened, and water flowed out more or less rapidly in proportion to the size of the opening, which at last, of course, was governed by the suck of the solenoid, a sort of temperance ampère-meter. An automatic syphon emptied the reservoir and then it filled. The quantity of water was assumed to be directly proportioned to the flow of current. See Fig. 1. In Blythe's ampère-meter, a vertical solenoid has an adjustable core suspended from a spiral spring. A vernier gives the direct reading of from one-tenth of one ampère to 100 ampères.

The Deprez-Carpentier ampère-meter came to the front about this time in the succession. It contains two permanent magnets, bent half way round the inner circumference of a circular box. When

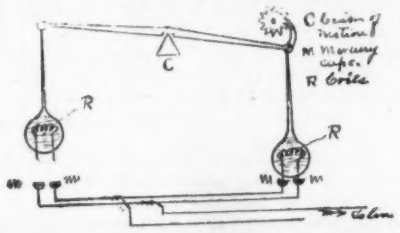


FIG. 3.—HASKINS ON STATION MEASURING INSTRUMENTS.

nearly at the quarter of each side, the ends are bent inward, parallel with the diameter, and extend parallel with it until they nearly touch. Now we have two magnets, each not wholly unlike the capital letter *C*, with the open portions facing each other in the middle of the box. In the space left by the magnets, where the four poles so nearly join, is an electro-magnetic coil, which carries the needle and is actuated by the current traversing it. This was a bold step in advance. Kapp modified the Deprez-Carpentier instrument by making the magnets electro-magnetic, instead of permanent. The scale was graduated experimentally, and the instrument was formed for an ammeter or voltmeter, according to the size of wire used. Here was quite a radical departure. Uppenborn developed a novel idea in the use of an eccentrically shaped armature lying on a simple electro-magnet core, and a pointer fixed to the same axis as the armature. The pointer stands at one end of the curved scale when at zero. As the current increases, the eccentric face of the rolling armature gives to the pointer a movement along the scale, and a direct reading may be had. This graduation is arbitrary—done by a sort of cut and try method, or thumb rule. The improved voltmeter of this form has two coils instead of one, the greater to extend its sphere of usefulness. A switch gives choice of the coils.

There are forms in which the needle is loaded with small magnets, and the poles of electro-magnets are so placed as to double the magnetic action of these on the balanced needle. The molecu-

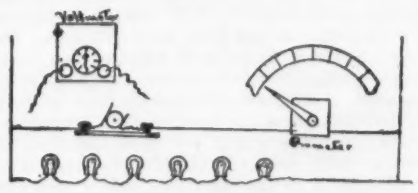


FIG. 4.—HASKINS ON STATION MEASURING INSTRUMENTS.

lar structure of glass is so affected by the magnetism as to change the direction of a beam of light transmitted through it, and this property has been taken advantage of to measure currents of electricity by the deflection of a ray of light. In one of that form of voltmeter, which measures current by the expansion of a wire through the heat generated by the passage of a current, some improvement has been made. In this a wire of platinum silver is inclosed in a brass tube held in tension by springs or weights. Formerly the absolute tension of the wire did not give exact results if the wire was exposed to changes of atmospheric temperature. Even when not in use the zero of the instrument is changeable. In the more recent instrument the brass tube surrounding the wire is made to have the same coefficient of dilitation as the wire itself, so that by compensation the zero remains very nearly absolute. The outer air has no longer any power to change and falsify the record of the instrument. Another form of voltmeter in which the dilatation of a wire is utilized to measure current pressure is a modification of the last. There were unforeseen difficulties in the way of accuracy. The increased length of the wire was assumed to be solely due to heat expansion, but investigation showed that with that expansion there must be considered the change in stress consequent upon the elongation, and the accompanying increased sag. A remedy very similar to the former remedy was applied, and the work is now sufficiently correct for all practical purposes.

A French invention is dependent for its results upon the action of solenoid attraction upon a movable core, the depth of this plunge being compensated by a weight which slides on a steel yard arm attached to the pointer a method of weighing the current. Deprez, according to Niaudet, conceived the idea of valuing current by weighing it by the aid of a solenoid coil. The scale of proportions was arrived at by actual experiment. A certain known current balanced a given weight. A second current would balance a greater or less weight, according to its quantity, and thus he was enabled to say "with a magnet of such and such proportions I find that a current which weighs blank grammes is a current of 10 ampères."

A well-known inventor has endeavored to utilize the heat generated by a current to turn a horizontal wheel, against the diagonal paddles of which the rising air impinges. In another form there are two upright solenoids and two cores. These cores are fixed to, and are a part of, a rectangular frame which moves on two centres at the middle of the top and bottom bars of the frame. At two diagonally opposite corners the cores are placed, and the winding of the coils is such that when one core is sucked up into one coil, the other is drawn downward into the other coil. This see-saw motion is communicated to the pointer from its being fastened to the frame at the upper centre of motion. A counterweight tends to hold the pointer at zero when in a state of rest. See Fig. 2.

Measurement of the gases developed by the electrolysis of acidulated water was one of the first as well as simplest of apparatus. Secondarily, the heat so generated has been made to do duty as a meter. An ingenious German inventor endeavored to utilize the heating effect of current by the aid of a double thermometer, the two branches connected with a thermople in a way to increase the temperature in one branch an reduce it in the other, through the Peltier effect, when current is sent through the thermopile. Walker, in 1885, and Wolf, 1886, also utilized the electrolysis of

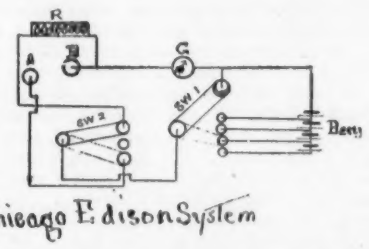


FIG. 5.—HASKINS ON STATION MEASURING INSTRUMENTS.

acidulated water with platinum electrodes. A Russian electrician measured the time necessary for the evolution of one cubic centimetre of hydrogen by a given number of ampères of current. From this as a starting point he has formed a table showing the time necessary to disengage one unit of gas with one unit of current at temperatures varying from 15 degrees to 24 degrees centigrade.

A German was among the first to discard springs and permanent magnets in ampère-meters and voltmeters. His instruments were galvanometers, with regulating pieces of soft iron for adjusting the index pointer. An English firm followed about the same time with a novel idea in ammeters, in which the compound action of magnet upon magnet was utilized. To escape the use of springs and permanent magnets, a French inventor produced an instrument in which a plate of soft iron is affected by opposing magnetic influences, being both repelled and attracted. The use of this instrument requires either a mathematical education, by means of which to calculate the result, or some other instrument of a simpler character to verify the work, The use of this form of meter is not unlike reading fiction to learn history. If the reader knows the history beforehand he does not need the fiction. If not, it may be somewhat difficult to separate the true from the false.

Simplicity is made simpler in another form, where the inventor uses an electro-magnet with a multiplicity of armatures, each held back by its own retaining spring. The more current you use for bait, the more armatures you will catch. All you need to do is to count them. A novel form had its origin in Berlin. In this, the pivot of the index needle lies within the solenoid, and one or more short, fine wires are attached to this centre, at about right angles to the needle. The magnetic action tends to set these, which are in fact one armature, at right angles to the current, and as a consequence, the indicator is moved along the scale. The weak point in this and many other clever instruments lies in the fact that magnetic action is not proportional to the angle of deflection, but to the tangent of that angle. An Austrian inventor places the needle between two contact screws, and any deviation from normal voltage closes the circuit through one or the other of the two coils, having differently toned bells, so that the employés are warned not only that the pressure is changed from normal, but whether it is above or below that point.

A European device, in quite extensive use on the continent, has two clocks, with pendulums so adjusted that in their normal condition their motions are perfectly synchronous, though independent of each other. One of these pendulums terminates in a fork, which holds a spool of fine wire, and this last is free and swings back and forth in a coil of coarser wire, like a core in a solenoid coil. The main current energizes the larger or stationary coil, while the movable coil of fine wire is in a derived circuit from the main line. The mutual action of the magnetism in the two coils, of course, varies the pendulum motion, and a set of clock-face counters—similar to those on a gas meter—registers the amount of current.

The heat developed by resistance offered to the passage of a current has been utilized to vaporize a liquid and produce motion in an ingenious manner. A horizontal lever has dependent from either extremity a closed bulb, containing a fluid. The two bulbs are connected, and in their normal condition are balanced. Within the fluid a coil is placed, its terminals extending down through the bottom. When either bulb is depressed these terminals dip in mercury cups and complete the circuit. Heat is generated in the coil, the liquid is vaporized, and the vapor makes its way over to the other bulb, where it is condensed. By and by the balance is destroyed and the beam tips, breaking the circuit on one side and making contact on the other. The operation is repeated alternately from either direction, and every time it makes one complete vibration a ratchet wheel is pushed one notch ahead by a dog attached to the tilting lever. See Fig. 3. To obtain a permanent record of the meter's work, a well-known French maker of instruments of precision added a revolving drum of paper, on which a pencil attached to the index lever traces the variations of voltage.

A very clever method of getting the pressure of a high voltage system by means of a low voltage instrument has been used with fair success by the aid of high resistance incandescent lamps. A sufficient number of these, arranged in series, are placed in a derived circuit around the motor dynamo or lamps. When the proper number of these is introduced in the circuit to bring their candle power up to proper brilliancy, the lamp resistances are measured separately, and the aggregate is comparatively the difference of potential between the terminals,—a good approximate system where no better can be obtained. See Fig. 4.

Of electrolytic meters there have been many. One of novel construction is an American invention. In this apparatus the entire line current is passed through a solution of caustic potash. The gas evolved, after being forced through water to clear it of froth or other impurities, passes into a meter similar to that used for gas measurement, whence, after having moved the dial, it is permitted to escape into the open air.

In this class of meters there are probably none better known than those in use by the Edison system throughout this country and Europe. Their action is based on the electro-chemical deposit of zinc, an average of 1,224 milligrams of zinc per hour per ampère. Of these, for different purposes connected with that system, several have been brought out. A very ingenious one, with which you are all familiar, has the lamp attachment, by which a safe temperature is insured to the meter.

The Wheatstone bridge principle is used in one form of pressure indicator for constant potential plants. The circuit to be measured includes a lamp through which the current flows. The amount of current passing is determined by its voltage, and the resistance of the filament is measured by the heat developed. The scale is so graduated that at any time when the needle of the galvanometer is brought to zero, thus balancing the bridge, the index pointer gives a direct reading of the current pressure. Another modification of the bridge principle is used for constant potential current measurements. In this form one or two standard cells are placed in derived circuit around a variable resistance. The battery is opposed to the current under examination. When, by sliding the contact along the scale the needle is brought to zero, the pointer indicates the voltage sought.

When the question is of meters for alternating currents, the problem is much more complicated, but the inventors, nothing daunted, have, since the comparatively recent introduction of these systems, done an immense amount of attempting with some success. Many of these are of such recent birth that patents have not yet been secured, and inventors are somewhat reticent about having their little ones paraded before the electrical public too early, for reasons of their own. Siemens' electro-dynamometer was one of the earliest instruments for measuring the potential of an alternate current. In this the inventor availed himself of the mutual reaction between two coils, one within the other. The inner coil is connected to the circuit on one side through the torsion spring which holds it in suspension, while the other terminal rests in a mercury contact. This arrangement permits of a rotary motion without breaking the connection. The deflected coil is brought back to zero until it will no longer deflect. The pointer gives a reading which is proportional to the square of the current. It will be readily seen that no matter how often or how slowly the alternations take place, the result must be the same, for no sooner does the direction change in one coil than the other is similarly affected. Another form of induction instrument is described in a German technical journal. In this there are no less than four coils, two main and two secondary. A Wheatstone bridge figures in the combination, and plays an important part in the apparatus which is too complicated in its detail for any but an extensively illustrated explanation.

As early as 1884, the current itself was made to do duty in energizing an electro-magnet, as up to that date permanent magnets were unsatisfactory; but Weston's new instrument, in which a permanent magnet is used, I have seen tested with very rough usage without perceptible change. The method of magnetization, I believe is known only to the manufacturers.

Objection has been made to the use of springs in measuring instruments, because of an assumed liability to change in form or elasticity. This assumption seems to me fallacious when we consider the reliability of delicate mechanism like time-keeping machinery, in which a spring not only furnishes the motive power, but a spring as delicate almost as it is possible to make, is the regulator as well, and when we remember the permanent molecular changes which might be expected to arise from the rapid doing and undoing of the delicate hair-spring, or the heavy and powerful daily movement of the driving spring.

Many more systems might be mentioned. Indeed, one hardly knows where to stop, for every weekly report from Washington adds to the list of instruments for the measurement of either pressure, or quantity of work, or something. Many that I have mentioned are out of place, save in the laboratory, while as to the correctness of the results obtained, electrical doctors disagree to an alarming extent. As a result, the majority of ampère-meters in industrial use are to day known as ammeters, and for simplicity of structure are little more than a stick and a string—a hollow coil, which is the arc of a circle, the centre of which is the centre of motion of a radial arm terminating in a wire core, with an index arm attached, which in a state of rest stands at zero. A solenoid, with a direct reading scale—that is all. If correct, it is all that is necessary—but who knows? Of the more complicated apparatus much may be said as to its accuracy of action. Those in which permanent magnetism is used have not hitherto retained the magnetism constant, and it is a mooted point between certain French and English electricians whether there is any method by which an accurate measurement of an alternate current can be made by any known process. In a discussion of this nature, I can see perfectly well a little way back, and do not purpose venturing an opinion. The change in the magnetic power of a horse shoe magnet has sometimes been attributed to the careless method of removing and replacing the armature. Prof. Hughes has suggested that the only constant magnet is one which, after thorough saturation, is hammered until every possible trace of its magnetism is driven out of it. The small residuum is permanent, and not likely to change. Dr. Hopkinson, with other lesser lights, has repeatedly found that the employment of an astatic needle is imperative in the neighborhood of magnets and magnetic fields. The use of an iron casing does not thoroughly obviate the difficulty. The necessity for a constant is a serious drawback to the ordinary user, even should the calibration of the instrument remain unchanged. The use of battery by which to energize an electro-magnet introduces another serious inconvenience. A standard battery is not at all times readily attainable—is not inexpensive, and may possibly be unreliable.

In galvanometer work with a portable battery of standard cells, I have noted a marked difference in deflection through standard resistances, which I could not explain. The importance of convenient and constant, as well as simple apparatus for the measurement of current flow, as well as potential, is of easy comprehension. It may be summed up in a single sentence, which might appropriately be framed and hung in the dynamo room, as a hint to the engineer and the dynamo tender. "It takes money to buy coal." Excess of pressure in a constant potential system means, as an electric light man once tersely remarked to me, "coal wasted, filaments busted, patrons disgusted." There is always a triangular duel between the patron, the company and the coal pile on the subject of ampères, volts, candles and lamps and dollars. Now and again the wire men, too, are drawn into a wrangle on the subject of insulation, or the armature complains in a very feeling way that it has been abused needlessly. Thus, from every standpoint, the necessity of keeping a safeguard over undue waste is a vital question with the electric light men.

Hand in hand with apparatus for measuring current flow and current pressures should go instruments of precision for the daily measurement of line insulation and copper resistance. I use the phrase "instruments of precision" advisedly, as the only known apparatus in many localities, and in far too many stations, is as distant from being an instrument of precision as a bell-hanger is from being an electric wire-man. As you are probably aware, this conviction is not a recent one with me. If there is any one thing in the whole business of electric lighting for which I have the most thorough and uncompromising dislike for testing circuits, it is the magneto bell. I wish I could feel that all my hearers were in full sympathy with this sentiment. The objections to the ordinary magneto are many and positive. In the first place, it is an alternate current generator, and will ring on a perfectly insulated line of sufficient static capacity, as readily as with a dead ground. There is positively no way of determining how much insulation resistance there is in the line. It will ring or it will not, and that is all you ever know. There is no degree of measurement. With one person who grinds it there will be a ring, while a less vigorous employé will fail to make any impression upon it. It becomes in the hands of linemen who are encouraged to use it a scape goat for neglect, for laziness and a loss to the owner of the plant. It has not the range required for proper insulation of an arc line, nor even for a 50-light incandescent plant. The range of the ordinary magneto is less than 15,000 ohms.

With a tangent galvanometer, the measurements may be made by a little exercise of pencil and paper, and the aid of a table of tangents. The intensity of the current, as measured by the tangent galvanometer, is proportional to the tangent of the angle of deflection of the needle. We will first obtain a constant by the measurement of a known resistance—say 10,000 ohms. Any other known resistance would be as well. We note the deflection, and turning to a table of tangents, note the tangent of 30 degrees. We next connect one pole of our battery to earth, and the other terminal to the galvanometer, which latter is connected to the line. All detectors and other earth attachments having been removed, the whole is now a metallic circuit. Closing the key, we note the deflection in degrees of our line insulation, and find the tangent of that figure in the table.

Now, the tangent of the first deflection, multiplied by the known resistance, 10,000, and divided by the tangent of the second deflection, will give us the number of ohms of line insulation resistance. Or, its tangent is to the deflection through the known resistance as the tangent of the second deflection inversely is to the unknown resistance. A very convenient little combination has been much used in Chicago, which answers an excellent purpose in construction work and testing, where all that is necessary is to reach a maximum insulation. In a small box, a battery is placed with a switch for connecting with a galvanometer through a standard resistance coil, or to line. Two binding screws receive the line connection and the earth wire. Having placed the galvanometer needle in the magnetic meridian, the switch is turned, throwing the current through the known resistance. Note the deflection. Then switch to line. If the galvanometer needle deflects less than before, the insulation has more ohms resistance than the standard coil. A switch enables the operator to use any number of cells, from one to the full number, so that within a somewhat limited range considerable accuracy may be attained. See Fig. 5.

Every now and then the suggestion is made to place a permanent ground on an arc line, in order to know when a second ground occurs. The use of a safety fuse comes in at once as a natural sequence. The suggestion is fraught with great danger to both life and property, and takes no heed of the time it requires a good healthy current to "get there." While it is true that the first ground does no harm *per se*, it must be remembered that without a first ground a second ground is an impossibility, and the second ground is the troublesome one. There is a fascination about rigging up some sort of an arrangement for telling when there is trouble, rather than to keep the trouble at bay on general principles. An acquaintance brought to me one day, with his face all aglow, a sketch of a piece of clockwork, ingeniously arranged to make an instantaneous contact to ground once an hour while the plant was running. This ground contact had, between the line and ground, a safety device which held up a key to a second circuit, that could only close when the fuse melted. On this second circuit he had a battery and a bell located so that every one in the room must hear it, and continue to hear it until it was switched out or the battery ran down. It never worked, for I convinced him of its impracticability by asking him to form the second ground through his body as an experimental test.

Testing sets are made by various firms, which do excellently well for the species of measuring which may be necessary about the station or on the line. The combination includes a Wheatstone bridge with a normal capacity up to over a megohm, and down to fractions of an ohm. With an additional box containing extra coils, and a split plug and cord attachment, this capacity may be carried to twice or three times its ordinary capacity. A battery and galvanometer finishes the set, which is made up in two portable cases. No electric light station or plant of any consequence should be without some such means of electrical measurement, and no dynamo should be run without a daily test of insulation and a test of copper resistance. A bad joint may cost many pounds of coal, but a ground leak may be far more expensive in many ways, while both may be prevented by the proper constant use of a set of testing instruments. A daily record should be kept of these tests, together with the condition of the weather, etc. I have read somewhere of a ladder which was seen in a dream, the three principal rounds of which are faith, hope and charity, the greatest of these being charity. We have in the electrical ladder three principal rounds also. They are current, potential and insulation.

The PRESIDENT: If there is no objection, before proceeding with the discussion of Mr. Haskins' paper, we will hear from Mr. Rhodes on the economic size of line wire.

Mr. RHODES: My paper is so uninteresting and unintelligible, that the only way I can get it attention is to distribute printed copies. The writer has for some time been accustomed to use a formula for finding the size of line wire, and he has been requested to present it at this time. With the knowledge that it is not strictly new, and yet that it is needed by all practical electricians, the following is submitted:

ECONOMICAL SIZE OF LINE WIRE FOR CONSTANT CURRENT CIRCUITS.

The writer has for some time been accustomed to use a formula for finding the economical size of line wire for constant current circuits and has been requested to present it at this time. With the knowledge that it is not new, and yet that it is needed by many practical electricians, the following is submitted:

Let X = diameter of line wire in mils.
Let A = length of circuit in miles.
Let B = price of copper per pound.
Let C = cost of power per year per horse-power.
Let E = ampères of current.

When any plant is about to be established, B and E are known, C can be determined near enough for our purpose, and A will be found to be immaterial.

$.016\ X^2$ = pounds of wire per mile.
$.016\ B\ X^2$ = cost per mile of wire.
$.0016\ B\ X^2$ = interest and depreciation at 10 per cent.
$.0016\ A\ B\ X^2$ = annual cost of wire. (1)

$\frac{54,577}{X}$ = ohms per mile.

$\frac{54,577\ E^2}{X^2}$ = watts per mile.

$\frac{54,577\ E^2}{746\ X^2}$ = horse-power lost in transmission per mile.

$\frac{54,577\ C\ E^2}{746\ X^2}$ = cost of same.

$\frac{54,577\ A\ C\ E^2}{746\ X^2}$ = annual cost of power lost in entire circuit. (2)

It is plain that with any increase in the size of wire the value of (1) will increase, while (2) will diminish, and the economical value of X will be such that the sum of (1) and (2) will be a minimum.

Let u = this sum:

$$u = .0016\ A\ B\ X^2 + \frac{54,577\ A\ C\ E^2}{746\ X^2}.$$

$$\text{Differentiating, } \frac{d\,u}{d\,x} = .0032\ B\ X - \frac{109,154\ E^2 C}{746\ X^3}.$$

Placing this equal to zero, and reducing, we have:

$$X^4 = \frac{45,700\ E^2\ C}{B}.$$

This formula shows that the diameter of wire depends on the price of copper, cost of power and quantity of current, and is entirely independent of the length of the circuit and the voltage.

The differential co-efficient shows that the formula is in harmony with Sir William Thomson's rule that "the additional running expense due to the resistance of the conductor shall equal the interest on its first cost."

Price of copper refers to the bare wire without any covering or insulation whatever. The insulating cover is a mere matter of choice, like a brick, stone or frame station.

A few examples are added for illustration, the price of copper assumed at twenty cents per pound for facility of calculation.

What size wire should be used in a transmission of power plant using a 40-ampère current, power costing $100 per year per horse-power?

Here $E = 40$, $C = 100$, $B = 20$. Substituting, $X = 427$ mils, or nearly No. 0000 wire B. & S. gauge.

If the power cost fifty dollars per year then C = 50 and X = 359, or 00 B. & S. With water power at ten dollars per year, X = 240, or between Nos. 2 and 3 B. & S.

Should a 20-ampère current be used in the three cases above, the results would be respectively:

$X = 302$, larger than No. 1 B. & S.
$X = 250$, larger than No. 2 B. & S.
$X = 170$, between No. 5 and 6 B. & S.

What size wire is economical in an ordinary city arc light ten ampère circuit, steam power costing fifty dollars per year.

$E = 10$, $C = 50$, $B = 20$;
giving $X = 180$ mils, or No. 5 B. & S.

Suppose water power can be furnished at Niagara Falls for ten dollars per horse power per year and a ten-ampère current generated by this power be used for street lighting in Buffalo, the entire length of circuit being fifty miles, what is the economical size of line wire?

A substitution in our formula gives $X = 120$ mils, equal to No. 8 B. & S., or exactly No. 11 Birmingham wire gauge.

In conclusion Mr. Rhodes explained that the No. 11 Birmingham wire gauge wire carrying the 10-ampère current between Niagara Falls and Buffalo, would be one-half of the diameter of an ordinary lead pencil.

The PRESIDENT: Gentlemen, you have before you the papers of Mr. Haskins and Mr. Rhodes.

Dr. MOSES: I move that they be received and filed and spread upon the minutes.

The motion, after being duly seconded, was put and carried.

The PRESIDENT: Gentlemen, we have for the special order of business at 11 o'clock, which has very nearly arrived, the report of the Committee on the Revision of the Constitution and By-Laws, through its chairman, Dr. Moses.

Mr. MORRISON: Mr. President, have you not printed copies of the Constitution that can be distributed to the Association?

Dr. MOSES brought in a number of printed copies showing the old and new constitution, and they were distributed among the members.

Dr. MOSES: This report is of a committee of five appointed at the Chicago convention, who were invited to report at this convention some necessary amendments to the constitution. The opinions of all the members of the association were sought with regard to certain changes thought advisable then, and we have a mass of material amounting to some 125 letters, some of them quite carefully written, and giving great encouragement to the committee to proceed in these amendments, which are on file with the secretary. The amendments are not many, but comprise a change of some importance in the form of the constitution; and I will call your attention to a few of these points after I have read the proposed constitution.

Dr. Moses then read the proposed constitution, as follows:

THE NEW CONSTITUTION.

ARTICLE I.—*Name.*

This Association shall be entitled THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

ARTICLE II.—*Object.*

The object of this Association shall be to foster and protect the interests of those engaged in the commercial production of electricity for conversion into light, heat and power; and of manufacturers of apparatus and supplies used in these industries.

ARTICLE III.—*Members.*

SECTION 1. Members shall be divided into three classes, Active, Associate and Honorary, of which the first only shall be entitled to vote.

SEC. 2. Active members shall be: Corporations or individuals engaged in the business of producing and supplying electricity for light, heat or power, for commercial or public use; and the members of the Executive Committee.

SEC. 3. Associate members shall be Electricians, Electrical or Mechanical Engineers, Manufacturers, and individuals who are otherwise directly or indirectly interested in advancing the uses of electricity.

SEC. 4. Honorary members of the Association may be elected upon the unanimous recommendation of the Executive Committee and approval by a two-thirds vote of the Association.

ARTICLE IV.—*Officers.*

SECTION 1. The officers of the Association shall be a President, two Vice-Presidents, a Treasurer and a Secretary, and an Executive Committee, to consist of the above-named officers, *ex-officio*, and nine other members, of whom three shall be selected from among the Associate members.

SEC. 2. The President and Vice-Presidents shall be elected by

ballot, to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting.

SEC. 3. No person shall be eligible for the office of President or Vice-President for more than two successive terms; but this shall not be construed to forbid the election to the office of President of one who has served as Vice-President.

SEC. 4. The Secretary and Treasurer, who may be one and the same person, shall be nominated by the President, subject to confirmation by the Executive Committee. The salary of the Secretary shall be fixed by the Executive Committee; and he shall have an office in the city of New York.

SEC. 5. The Executive Committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, and shall hold office from the close of the meeting at which its members are elected until the end of the meeting at which their successors are chosen.

SEC. 6. The Treasurer, Secretary and Executive Committee shall make written reports at each meeting, which reports, upon their acceptance, shall be spread upon the records of the Association.

SEC. 7. The Executive Committee shall be the governing body of the Association. It shall meet at the call of its Chairman from time to time, and shall report upon applications for membership, shall gather and prepare information upon topics of interest, and shall arrange for discussions at the several meetings of the Association. Five members of the committee shall constitute a quorum.

ARTICLE V.—*Meetings.*

The Annual Meeting of this Association shall be held in February, and a Semi-Annual Meeting may be held in August of each year, at such places as the Association shall determine, and on such dates as may be determined by the Executive Committee.

ARTICLE VI.—*Dues.*

THE ANNUAL DUES SHALL BE $20, PAYABLE IN ADVANCE, AND SHALL COVER THE CALENDAR YEAR.

ARTICLE VII.—*Ballot.*

A ballot may be demanded by ten of the members present on any question before the Association.

ARTICLE VIII.—*Amendments.*

SECTION 1:—Amendments to the Constitution shall be presented in writing and shall be referred to a committee, to be appointed by the chairman, before being acted upon by the association, a two-thirds vote of those present shall be necessary to their adoption.

SEC. 2.—No amendment shall be voted upon on the day of its first presentation.

OTTA A. MOSES, Chairman,
WILLARD L. CANDEE,
A. J. DE CAMP,
MARSDEN J. PERRY,
H. D. STANLEY, } Committee.

Dr. MOSES: In this proposed constitution, gentlemen, you will notice that there are certain changes, some of which affect myself and others of my committee materially; but it was thought by me and my coadjutors in this matter that it was important that these changes should be brought about in order to give more homogeniety to the association, and to give it its true position as a body. I hope that the mature deliberation that has been given to this, the labor that has been expended upon it and the disinterested feeling that has prevailed in forming it, will be acceptable to you.

Mr. BROWN: Mr. President, I move that the report of the Committee on the Revision of the Constitution be accepted.

The motion was seconded by Mr. De Camp.

Mr. LYNCH: Mr. Chairman, I would suggest that as this proposed constitution is very important we take it up *seriatim* and discuss it, article by article, and pass upon it so. One or two little changes I would like to suggest, and I think that would be the most satisfactory to all.

Mr. MORRISON: The motion is not in order. You accept the report, and then discuss its provisions.

On motion, duly seconded, the report was accepted.

Mr. BROWN: Mr. Chairman, the report of the Committee on the Revision of the Constitution having been accepted, I would now move you that a committee of five be appointed by the president for the formulation of by-laws or rules of order for the association.

Mr. PHELPS: I second that motion.

Mr. WHIPPLE: Do I understand that this constitution has been adopted?

The PRESIDENT: Accepted.

Mr. WHIPPLE: What do you mean by "accepted"?

The PRESIDENT: That it is now the constitution of the association.

Mr. WHIPPLE: There is a difference of opinion here as to whether this matter is before the convention, or whether it has been adopted.

The PRESIDENT: The ruling of the chair is that it is now the constitution of the association. The word used by Mr. Brown was "accepted."

Mr. WHIPPLE: Does that adopt the report—the acceptance of the report does not, as I understand it, adopt it. If the report had been received that would be right, but it was accepted and was open for discussion.

Mr. LYNCH: My motion was made with the understanding that the report was to be received. I do not think we should quibble as to whether it is adopted or received. Some of the members want to talk on the changes meditated in the Constitution.

The PRESIDENT: The discussion is out of order. All discussion to this point must be on Mr. Brown's motion for the appointment of a committee of five on by-laws.

Mr. MORRISON: I move as a substitute that the Executive Committee be instructed to prepare by-laws.

Mr. BROWN: I accept that amendment.

This motion, being duly seconded, was carried.

Mr. WHIPPLE: I move that the motion of Mr. Brown to accept the report be reconsidered.

Mr. BROWN: I would like to ask how the gentleman voted on that question.

Mr. WHIPPLE: The gentleman did not vote at all.

Mr. BROWN: I rise to a point of order that as he did not vote upon the question he cannot call for reconsideration.

The PRESIDENT: Mr. Brown's point is well taken. We will now hear from Mr. G. W. Mansfield, of Boston.

Mr. LYNCH: I think I voted on that subject, although my voice was very low. (Laughter.)

The PRESIDENT: The chair rules that Mr. Mansfield has the floor.

Mr. MANSFIELD: Mr. President, Members of the Association, Gentlemen and Ladies: It gives me pleasure to be able to present this paper before you to-day upon the application of electricity to street railways.

The following paper was then read by Mr. G. W. Mansfield on

ELECTRIC RAILWAYS.

The application of electricity to street railways has been so rapid that we are liable to lose sight of many valuable points in our herculean efforts to supply the demand. Those who are engaged in it know that they let many opportunities slip by. They cannot help it. The more generally, however, the points are known the quicker will be the reward to some directly, and to them indirectly.

The application of electricity during the past decade has been astonishing. In the face of an industry a half century old, and of enormous wealth and power, it has won the leading position. In every direction that honest effort has been made it has succeeded. Commercial barriers have been broken down and physical obstacles swept aside. When once the feasibility was demonstrated the end could not be predicted.

For the transportation of the people in the streets of our towns and cities the demonstration has been witnessed, the application made and a wonderful luxuriant growth started. There is no industry so far reaching in character, so vital to a community's interests, and yet one so little known as the street railroad business. Neither the scientific world, the commercial world, nor the people themselves have realized its vast importance. Eliminate the horse car from every city or town in the union and forecast the results.

In 1828 the now great Baltimore & Ohio Railroad started and horses were used to draw the cars. This might be called the first horse car line in the United States. In 1830 there were 12,866,020 persons in the United States, and not a mile of street railroad nor scarcely of steam road. As a rule, the New York & Harlem Railroad, incorporated in 1831, is spoken of as the first street railroad in the country. The first car was run in November, 1832, from Prince street to Harlem Bridge. In 1837 it temporarily succumbed to steam cars, but resumed in 1845.

The census of 1850 gives our country a population of 23,191,876, and published history but one street railroad. The child had been born, however, and in 10 years the street railroad was in almost every city of any magnitude in the country. To what has this child grown? In 1880 our population was 50,155,783. Estimating on an increase of 33⅓ per cent. in 1890, or six months hence, the population will be 66,874,554. For the transportation of this number of people in the streets of our cities and towns the most accurate figures it is possible to obtain show the engagement of about 425 companies, employing 28,000 cars, 125,000 horses and operating some 3,500 miles of track. The capital invested is variously estimated from $175,000,000 to $200,000,000. The number of passengers carried is so enormous that it is impossible to obtain figures of any great degree of accuracy. As a result of most careful compilations and estimations it is reasonably sure that at least 1,500,000 passengers are transported.

Still more striking is the importance of the street railroad business when compared with the magnitude and extent of the steam railroads of the United States. The figures of 1887 show a tabulation of 147,998.60 miles of railroad and 20,582 passenger cars, and passengers carried but 428,225,513. With nearly an equal number of cars and 42 times more road, only one-quarter as many passengers were carried. Behold the yet more amazing figures: The horse cars of the city of New York carry 199,491,735 passengers, almost half as many as are carried by all the steam roads in the United States. If to this number are added those carried by the elevated roads, we have the total of 371,021,524, or almost as many passengers are carried in New York City alone as are annually carried by all the steam roads in the whole United States. The street railroads of the State of Massachusetts carry over 44,000 000 more people than than all the steam roads in that State. One road alone, the West End of Boston, carries nearly 10,000,000 more than all the steam roads combined.

To show somewhat in detail where this tremendous traffic is, I have prepared Table I. Most of the figures showing passengers carried were obtained from reliable sources, and the balances were estimated from an average obtained from those I was sure in regard to. If you figure for each car six horse-power of electric energy it will give you a rough idea of the size of an electric central station needed to operate all the cars. In New York City dynamo capacity of 13,800 h. p. would be demanded, in Boston 9,504 h. p., and so on. This is destined to come as surely as the days succeed each other. In Boston it has come, and a station of approximately 8,000 h. p. is already in the hands of the engineers. If the conservatism of Boston permits it, how can the result be but inevitable for the other great cities of the Union. This enlightened age will have these facilities for transportation, and as soon as it is possible and wise. The universal cry to-day in almost every large city the length and breadth of the land is for cleaner, surer and more rapid transit.

Unfortunately the tendency of the times is to concentrate in or around large cities. This means congestion with all its deplorable results. The solution lies to a very large extent in the street railways. These must be the cities' arteries and veins extending from the heart in all directions to the extremities. Improve, then, the street railways. Almost every method of applying energy to street cars has been applied, and they all have finally, except electricity, "bitten the dust" in the great battle for life.

The Baldwin Locomotive Works have for years been engaged in the manufacture of steam dummies for street railways. Unquestionably through them the highest order of talent and skill has been lavished upon the solving of the vexed problem as to how to use steam for the haulage of street cars. Motors weighing from 13,000 to 27,000 pounds when in working order and ready to run have been built. In most cases two engines have been employed with cylinders and strokes ranging from 8 inches by 10 inches to 12 inches by 16 inches. The power of these engines can be judged from their pulling capacity, which varies from 320 to 634 tons on a level, and from 16 to 43 tons on a 4 per cent. grade. Ordinarily they were built to seat from 15 to 20 people. The wheel base was generally 6 feet and the wheels 31 inches in diameter. Naturally they were built to run at speeds from 10 to 15 miles per hour, and to be provided with all possible safeguards and conveniences. Powerful brakes were used, coke was burned to avoid smoke, mufflers provided for the exhaust and safety valves, and every other possible contrivance adopted to eliminate all objectionable troubles. Their economy in working has not been very freely published. From reliable and authentic sources we learn that the lowest fuel consumption is 6¼ pounds of coke per mile run. The average is from 15 to 12 pounds when ordinary grades are ascended. The total cost of operating per mile has been in some instances reported to be but 3½ cents, but in other cases it was found to be over 20 cents per car mile. It is needless to say that in spite of all the skill, time and money spent upon them, they have not proven, except in a few isolated cases, either satisfactory or economical.

Electricity, the youngest of them all in application, shows already the sturdy, vigorous growth that inevitably will result in its complete supremacy.

TABLE II.

ELECTRIC STREET RAILROADS.

	1885.	1886.	1887.	1888.	Jan. 1-July 1, 1889. Operating.	Building.	Total.	Total.
Number of electric railways	3	5	7	33	19	42	61	109
Number of miles of road	7.5	28	29	130.5	113	267	380	575
Number of cars	13	39	81	265	174	364	538	936

The figures of Table II certainly show that the facts warrant the prediction. They were most carefully prepared and include every road of any record. It does not show it all either. That remarkable contract which the West End Street Railway Company, of Boston, the largest street railway company in the world, signed recently with the Thomson-Houston Electric Company is not included under the heading "roads building in 1889." I think that this contract in responsibility and importance is one of the greatest that has ever been signed in the history of electricity. In electric railroading it is the greatest and probably will be for many years to come.

The West End Street Railway Company, of Boston, owns 217 miles of track and 1,584 cars, all of which are to be equipped so as to be operated with electricity. Add these to the list, and how does our list stand? If it be within the bounds of the supply men, at least 75 miles will be built this summer and 100 or more cars equipped. Will not this give the electric railroad industry a standing warranting the attention of the whole railroad world? As an interesting comparison regarding the new industry, if I may call it such, note the following figures:

	1870.	1880.	1890.
Total h. p., both water and steam, engaged in the whole manufacturing industry of the U. S.	2,346,142	5,410,837	Estimated. 5,255,582
Total h. p. engaged in the electric lighting and power industry	0	1,000	500,000
Total h. p. engaged in electric railway industry	0	0	30,000

TABLE I.

CITIES OF 100,000 POPULATION AND OVER.

Name.	Companies. Elevated.	Companies. Horse.	Miles single track.	Total trackage.	No. of cars.	No. of Horses.	Locomotives.	Total passengers carried.
New York	2		60	89	949		291	171,529,789
Brooklyn	3 miles cable included.	19	143	268	2,300	14,441		199,491,735
	3	14	135	207	2,355	8,410		105,975,249
		3	24	35	247		91	18,632,082
Boston		1	211	231	1,534	7,684		97,039,919
Providence		1	54	54	289	1,414		15,582 732
Chicago	44 lines in one system.	7	325	325	2,400	8,279		99,348,000
Philadelphia		12	302	326	1,512	,322	8 dummies.	143,433,959
St. Louis	3 cable.	14	169	169	1,058	4,231		50,772,000
Baltimore		12	158	158	460	3,167		34,837.000
Cincinnati	2 cable.	30 lines 7	164	164	530	2,644	4 dummies.	31,728,000
New Orleans		7	140	140	499	2,019	18 dum's. 7 loco.	24,228,000
San Francisco	2 steam. 8 cable.	10	163	164	707	1,724	3 loco. 39 dum's.	130,860,000
Buffalo		2	39	56	198	1,276		13,108,203
Washington		5	63	63	336	1,684		21,892,000
Newark		3	53	52	219	1,264		15,168,000
Louisville		2	112	112	378	Mules 2,270 Horses		24,970.000
Cleveland		7	123	123	523	2.521		30,252,000
Pittsburgh	6 cable, 1 electric.	13	113	113	347	1,924	3 dummies.	39,088,000
Jersey City		2	35	35	132	825		10,725,000
Detroit	3 electric.	4	65	65	263	1,682		32,184,000
Milwaukee		3	68	68	208	1,188	2 loco.	16,744,000
Albany		3	19	30	103	424		4,278,927
Indianapolis	Consolidated.	1	40	40	99	648		9,720,000
Kansas City	6 cable.	7	124	124	469	613	38 dum's and mot'rs	33,969,000
St. Paul	1 cable.	1	74	74	154	816		23,608,000
Omaha	2 cable, 3 electric.	1	61	61	167	580	24 motors.	20,540,000
Minneapolis	Consolidated.	1	66	66	160	1,104		14,352,000
Totals		189	3,103	3,414	18,645	77,884		1,434,057,595

Five elevevated roads, 27 cable, 147 horse, 7 electric, 3 steam and horse combined—189, total; 18,645 cars, 394 locomotives, 134 dummies and motors; 77,884 horses, 2,270 mules—80,154. About 24,000 horses are annually disabled.

In meeting this demand of the age for better transit there are many considerations that claim our most careful attention. The conditions to be met are widely different from all other electrical applications. Essentially we have first, a steam engine; second, a dynamo; third, a conductor, and fourth, a motor mounted upon a vehicle and subjected to mechanical and physical conditions more extreme and severe than ever heretofore has been imposed upon any piece of electrical machinery. In the battle for success the engine has to stand the bulk of the fighting. Anything wrong with it affects directly the electric system, and in many cases it also has to stand the blows if anything is wrong with the electrical system. Dr. Bell has pointedly shown in his valuable paper many well-known facts, and clinched them by figures taken on one particular road. They can be taken with certain allowances as fairly representing the conditions imposed upon the steam engine by an electric road.

The extreme liability of short circuits on the road from falling wires, careless drivers turning the current on too suddenly when starting, and a variety of accidents that may happen on the very best roads render of the first importance that the engine have its main moving parts at least 20 per cent. heavier than ordinarily.

Under the extreme fluctuations of load, keys, nuts and bolts will work loose. An engineer in a large station recently told me that he practically took to pieces and put together nearly every month a 100 h. p. engine running an 80 h. p. dynamo, whereas prior to the time that it had been connected to a railway dynamo it had given practically no trouble, although worked well to its capacity.

Hanscom, of cable railroading fame, writes: "We do not consider it good engineering to design an engine to suit the general average of all lines in the country." He argues special engines for every road. Mr. C. B. Holmes, president of the Chicago Cable Company, writes: "I would recommend that the strength of parts and weight of fly wheel be at least one-third greater than the usual run of engine power." Our business is analogous, and I think we should heed their counsel.

A compound engine rated at 109 h. p., running an 80 h. p. dynamo under test recently, gave the following:

Friction card with dynamo but no current, 11.65 h. p.
Aggregate horse power of cards, 1,247.74 h. p.
Average horse power of cards, 56.67 h. p.
Maximum card, 120.79 h. p.
Minimum card, 15.56 h. p.

The cards were taken at 10 minute intervals for four hours. There were at the time three electric cars on the line, each towing another. As the day was a pleasant Sunday, every car was crowded. During the same time current and potential readings were taken on the line at the station. The average gave 30 h. p., or an average efficiency of 54.6 per cent. for the total time. Every moment deducted that no current was flowing would raise this efficiency. At times the efficiency was far higher than this. The road conditions were severe, the grades ran as high as 10 per cent., and had numerous others of five and seven per cent. The extreme current fluctuations were noted in one minute's variation from 45 ampères to 140. The potential was very constant. On another small road the extremes varied from the friction load to nearly 85 h. p. on an 100 h. p. engine. These extremes would happen even during the time a three-impression card was being taken. Under such conditions the question of coal economy is a troublesome one. On large roads, unquestionably a far better showing would be possible.

Laying aside the question of coal economy, which is cheap in comparison to food for horses, the best engine is the one that handles the average work with the least repairs. On some small roads the ratio of engine friction to average daily load may be large. The great majority of roads, however, will have a sufficient number of cars to so reduce the ratio of extremes to the average load that the engine can work at its most economical point of cut-off the major part of the time, and raise the average load to such a point above the friction load that the per cent. lost will be comparatively small.

Almost the first question asked by the manager of an electric light company when an application has been made to him for power, is: "How much electric power must I allow per car?" No man can give a definite answer to this question that will meet all conditions.

If the following facts are known a fair judgment can be made, although I am much afraid that the accuracy of the judgment would not be that of a William Tell:

1. Number of cars simultaneously operated.
2. Speed and nature of service.
3. Maximum grade, and number of grades.
4. Scheduled location of cars in reference to grades.
5. Motor cars to be used to tow other cars or not.
6. Any peculiarities in regard to the distribution of cars.
7. Condition of track.
8. Location of track in reference to power house.

A moment's thought over any one of these points, I think, will convince you of its importance. On a portion of the Cambridge division of the West End Street Railway Company's road, of Boston, the Thomson-Houston Company's motors commenced running Feb. 16, 1889. Up to July 1, 165,781 miles and 25,505 round trips had been made with a loss of but 325 miles, or .19 of one per cent., and 49 round trips, or the same per cent of loss. During this time nearly 1,500,000 passengers were carried. This, in view of the fact that during the entire time one, and part of the time two, tow cars were drawn is remarkable. It must also be known that the route extends over one of Boston's most crowded business thoroughfares, and is the main street connecting Cambridge and Boston.

On a portion of the route there is an open bridge about 1,800 feet long, on which is located one draw, which is opened from 20 to 30 times a day. Over this bridge 1,810 cars per day pass, or on the average of one every three-quarters of a minute, and at some portions of the day they run at half-minute intervals. The teaming on this street is also very heavy, necessitating constant stopping. You will see from these figures what the loss of current or a motor burnout causing delay would mean. The record, however, has been magnificent. As the dynamos are run by the Cambridge Electric Light Company, and are so arranged that the same engines furnish power and lights for their own purposes, as yet only approximate data as to the fuel consumption, etc., has been possible. A few electrical tests have been made, as well as it were possible. Ammeter and voltmeter readings were taken at the station every 15 minutes, four readings per minute, or at 15 second intervals. This was kept up from 6.30 A. M. to 12.30 A. M. next morning for five days. In all, 1,480 readings were taken. The average of these readings gave for 12.6 cars in continuous service, 111.6 ampères, 500 volts, or 74.8 h. p. Per car this is 8.8 ampères and 5.9 electrical horse power. The average number of passengers carried was about 58 per round trip. We now have 32 cars in operation, and observations, in so far as they have been taken, show a marked decrease in horse power per car. At Richmond, Va., some rough tests gave the electrical horse power required per car at the station as from 4 to 5. On the road at Lafayette, Ill., the figures of Dr. Bell show the remarkable low figure of 2.5 electrical horse power. There are a number of circumstances on this road that would tend to make this figure so low. The cars are smaller than those ordinarily used, and I should judge that there were other circumstances entering into the calculation that would tend to reduce it. However, it well shows, possibly, one extreme in railroading.

The other extreme might be cited in the case of the Lynn road, Highland division. Here only one car is in operation. In the course of its route it ascends a hill graded at the rate of 8.7 per cent. for 300 feet, and immediately passes down on the other side. In this case the engine was indicated. Five cards were taken when the car was ascending the grade, the average of which was 52.2 h. p. If we allowed a dynamo efficiency of 90 per cent., this would indicate an electrical horse power of 47 h. p. This is unquestionably a very extreme and exceptional case. I might add, incidentally, that the car pays handsomely.

At Plymouth, Mass., a road having many heavy grades, the maximum being over 10 per cent., and operating but three electric cars, each with tow cars, the electrical horse power at the station per car was approximately 7.72 h. p. On the cars the extremes vary obviously according to speed, grades, load, etc. It frequently reaches from four to five times the average value during the total time. In Lynn the variation is enormous. In Cambridge the current frequently rises to from 65 to 70 ampères, or about 42 h. p. Especially is this the case on starting. You can see from these figures the impossibility of giving only the most approximate figures in this direction unless every detail as to operation and conditions are known. I feel, however, that on roads having no grades over 5 per cent., and operating under 10 motor cars with tow cars, 15 h. p. per car would be a safe figure for dynamo capacity. On large roads this figure could be reduced to 12 and possibly 10 h. p. per car, while on small 3 or 5 car roads with heavy grades 18 or 20 h. p. might not be any too much. At Cambridge tests show that, of the total time consumed by a car in a round trip, it was taking power only 61.8 per cent. of the time, and that 6.7 per cent of the total time the car was stopped. At Washington, where the streets were freer and not so thickly populated, the above figure for time when power was used rose to 66 per cent. Neither of these roads are what you might call large. It seems, however, that from 30 to 40 per cent. of power in excess of the absolute requirements can be planned for. I do not think, however, that this can be implicitly relied upon as in other power business, since there are many factors in the general operations of a railroad system that might at any moment tax the central station to its utmost. In regard to total electrical and total commercial efficiencies, it is impossible for me or any one else to give accurate figures. There are so many fluctuating factors entering into such a determination, that, whereas, a test made to-day would give me certain figures, a test made to-morrow, or a week later, would give me entirely different figures. The time factor must enter largely into such a test.

From estimations based upon many figures, I feel certain that a total electrical efficiency of at least 70 per cent. can be obtained, and a total commercial efficiency measured from the indicated horse power of the engine to the car-wheel horse power (W. H. P.) of from 45 to 50 per cent. If the road-bed, rolling-stock, and all the electrical apparatus is maintained as it should be, I see no reason why this figure cannot be exceeded.

Unquestionably, to the railroad man, one of the most vital points is the cost of repairs. We all know that in so far as power is concerned, a horse-power can be produced and delivered 10 hours per day the year round, with a profit, at about $75 per year. The cost of maintaining a horse for only about four hours' work per day on a horse-car is not far from $190.

There is one point which is of vital interest to the managers of electric light companies, and this is how they shall charge the railway companies for the power which they desire. I have already shown you that it is an exceedingly difficult thing to estimate upon the requisite power, as the conditions are so fluctuating and so variable. After, however, the question of the amount of power has been settled, the next point to determine is whether they shall charge the railway company by the hour, by the day, or by the car mile. We have a large number of roads already hiring power of local companies; all of the methods just mentioned are in use. Upon small roads where the schedule of the railway company is such that they have only a few cars running continuously, meeting emergencies by extras, and where the grades are heavy, a satisfactory basis has been to charge so much per day per car, the price ranging all the way from $3 to $5, $6 and even $7. When the roads are of moderate size, or are subject to many variations and sudden demands on the part of the public for better facilities, or when the line runs to some resort and the main bulk of business lay in picnics, etc., charges on the hour basis is sometimes preferred. This price varies from 15 to 30 cents per hour. On larger systems, where the schedule is definite and fixed, the mileage basis is the preferable by far. The prices on this basis range from two to six cents. You can readily see that if the cars ran at infrequent intervals, and if the morning and evening traffic was especially heavy and required a larger number of cars, while during the major part of the day only a few cars were out, the mileage basis would be quite unsatisfactory, since on the whole you would have to make steam possible for the maximum railroad output, and maintain it throughout the day. All of these estimates, however, can only be determined by knowing the local conditions and circumstances.

In the East, where coal ranges from $1 to $5 per ton, naturally the prices could not compete with the railroads of the natural gas and coal regions, where fuel can be obtained for almost nothing, as in some cases for 10 cents per ton.

I would like now to enter a wedge here in favor of the very best of construction. Your own experience has probably dictated that there is no economy if the original construction be put in with either inferior or faulty material or apparatus. It is more important in railroading than possibly in lighting that the overhead construction, the track circuit, the wiring of the cars and all other details be as perfect as it is possible for the best skill and brains to make them. If the light companies would require proper and reasonable guarantees in this direction, whenever they do supply power, it would not only be a surety in regard to their own protection, but also would be a strong inducement for the very best of construction work. The railroad man should see that it is for his interests, since there is no trouble that will consume profits more rapidly than breakdowns. There is no excuse now for electrical breakdowns. When such do happen it is either carelessness or cheap construction.

Railroading is an exact business. The cars must be ready and go precisely on time. Delays in railroading are ruinous. All such can be avoided by perfect, honest work. I call upon electric light men to strongly urge this most vital of all considerations upon the railroad world. It is an experience we have gained at a tremendous cost. Is it not to our interests to see that others becoming associated with us do not suffer? Should not all electricians bend all their energies toward making this new and richly-promising field a magnificent success? Have you not millions to gain and nothing to lose? Are you ready for it? Are you going to do it?

There are some 1,600 central electric light stations already located throughout the country, and some 425 railroad companies that sooner or later will have to have electric power. Is there any reason why you should not do it? I know of many a station that has to stint and save to tide over the year's dull seasons. You have no day circuits; are held by the sun to one schedule and by the moon to another. The municipal authorities jump at you from behind one post, and your commercial customers from behind the next. Stygian darkness is ever your salvation, and all conditions have to be met and illuminated by your beautiful light. You cannot afford to lose anything. Here is an opportunity for still one more chance at profit. If necessary, enlarge the scope of your charters. It will pay you. Your securities will be worth more, and can be more easily and satisfactorily placed. Railroads have an older and better standing in the financial world and on the money market than electric light companies. Can you afford to let the opportunity go by? From careful research, my own judgment would be that in many cases it would be the company's salvation. I believe the time is rapidly coming when great electric stations, from 5,000 to 20,000 h. p., are to be established. There are plants of from 5,000 to 10,000 h. p. already built for manufacturing purposes. I have been told that the Calumet & Hecla plant has in the neighborhood of 12,000 h. p. The New York Steam Heating Company have about 10,000 h. p. of boiler capacity in their stations at Greenwich, Conn.

There are many mills equipped with power of from 1,000 to 5,000 h. p. Even our ocean steamships are plants of from 8,000 to 12,000 h. p. Why cannot electric plants of such power be built? Why are they not? Is there not business enough in lighting, power and railroading? Almost every station I go into the country over is adding to its capacity. "New occasions teach new duties, time makes ancient good uncouth." The horse is uncouth. Electricity is our life.

Mr. Morrison: Yesterday the chair appointed Mr. Peck, of Brooklyn, as a member of a committee to present names to this convention as candidates for the Executive Committee. Mr. Peck, I understand, has gone home. It is desirable that a full committee should be had. I will therefore ask that the chair appoint somebody else in his place.

The President: The chair will appoint Mr. Brown in the place of Mr. Peck on that committee.

The paper of Mr. Mansfield is before you for discussion.

Mr. Morrison requested that the remaining members of his committee step into the side room, to prepare their report.

Mr. C. C. Martin: I would like to ask the gentleman who made that report what he means by a "day" in running street cars? Does he mean twelve hours or twenty-four hours?

Mr. Mansfield: Ordinarily it is a day of eighteen hours; that is about the maximum number of hours that a car runs per day.

Mr. Phelps: I would like to ask Mr. Mansfield another question. He gave us some very interesting and somewhat surprising figures as to the relative magnitude of street car traffic, and of the railroad traffic of the country on steam roads. They are most extraordinary, and very impressive as to the future of electric railroading. But I would like to ask him if he has made the comparison as to the number of passengers carried per mile between the steam railways and horse cars—the difference between the number of passengers carried per mile.

Mr. Mansfield: I attempted to make that division, but could not, because it is such a difficult thing to get at the mileage of horse cars on the various roads in the country and distances carried. The passengers get on and ride two blocks and then get off. It is such a difficult thing that I could not get any correct figures.

There being no further discussion, this topic was passed, with instructions to the Secretary to spread it upon the minutes.

The President: We will now hear from Professor Roberts upon the subject of the Electrical Transmission of Power.

Mr. Rhodes announced that there would be a meeting of the Executive Committee at Parlor A of the International Hotel immediately after adjournment.

Prof. E. P. Roberts then read the following paper on

THE ELECTRICAL TRANSMISSION OF POWER.

It has been impossible for me to take the time necessary to redeem my promise, made a month ago to Mr. Garratt, and therefore I have no carefully digested paper upon the electrical transmission of power, but merely a few notes arranged from material obtained on Friday last respecting the development of an interesting constant current dynamo and motor. When I stated to Mr. Brush that my paper for the convention was not written and requested permission to take some figures from the Brush constant current motor and dynamo, then being rushed through the shop for exhibition at this convention, he courteously acceded it. Upon last Friday morning the apparatus was hastily adjusted, and I was allowed some two hours to obtain such figures as might prove of interest. Although I consider the figures good, better could have been obtained if more time had permitted of closer adjustment of the motor governor, etc.

In order to interest you on this subject, allow me to briefly review the salient points of the largest installation yet erected of this type. The electrical papers gave last spring excellent descriptions of the electrical power plant on the Comstock lode, Virginia City, Nev., where six 120-h. p. generators operate six 80-h. p. motors. You will remember that each generator drives one motor; that each generator is driven by a Pelton water-wheel placed upon the shaft of the dynamo; that the wheels are actuated by water falling 1,680 feet, giving a pressure of 700 pounds to the square inch. Each wheel is controlled by a governor designed by Mr. W. B. Devereaux and his brother, Mr. J. H. Devereaux, of Aspen, Colo. Mr. J. E. Smith adjusted the governor at the mines. The generators run at 900 revolutions, all are independently driven, as before stated, and the motors turn 850 revolutions per minute, and all drive to the same shaft. An interesting feature is that to this same shaft is geared a surface water wheel and the water which actuates it, after passing it, drops one third of a mile, and in losing the potential energy it had at the power house it develops dynamic energy by two transformations back at the same point, and adds it to the small amount of dynamic energy it there developed.

The working out of the electrical mechanism to accomplish the above result is of great interest; particularly when we find it so successfully accomplished that orders are being given for similar apparatus for other mines, as well as for electrical railroad work and manufactories. A case of poetical justice has occurred in this line. The large Calumet & Hecla mines are about to erect five of these motors to assist in the production of copper, and thus electricity will assist to mine its chief servant, copper, as well as, in many cases, to refine it.

The generator will produce a practically constant current of 40 ampères from full load to a short circuit. As factors to produce this result are used compound winding and armature reaction. This introduces as variables in the design series ampère turns, shunt ampère turns, dimensions of armature, shape of pole pieces and length of cut-out segments. Changing any one of these produces a change not only directly due to itself, but also dependent upon the mutual interaction of these numerous factors.

Let us touch upon the subject of compound winding. Most machines have to be either long or short shunt, but the Brush machine can be intermediate between these if desired, because the action of the armature is the same as if three armatures were revolving, connected in series, and we can introduce one series coil anywhere in the circuit, and therefore make the shunt a "bye pass" to the external resistance and armature, or in the case of a twelfth coil machine to the external resistance, plus one-third or two-thirds or all the armature, or we can make a short shunt and cut it down to one-third or two-thirds the armature

The compound winding thus possible is evidently very flexible.

The characteristic desired is as shown in Fig. 1 at *E F*, and the straight portion will be the working part of the curve. If the machine were of the ordinary type of Gramme ring with small armature magnetism, the curve would be *A B*, and if armature reaction were powerful it would tend to be as shown in *C D*. The reason for this is considered later. If the Brush dynamo be separately excited, the characteristic is like *A C B* in Fig. 2. If a shunt winding is used, the characteristic is of the type *D E F*. The combination of these elements must be used to produce the dotted line *M N*. These curves are modified by the dimension of the iron and the copper in the armature, and this point can be advantageously dwelt upon for a mo-

ment. The magnetic axis due to the field magnets is as shown in Fig. 3, that due to the armature as shown in Fig. 4, and that of their resultant as shown in Fig. 5. The line of collection is at right angles to the commutator line, in the apparatus being considered, as an open coil armature is used. The stronger the magnetism due to the armature, the greater the distortion of the field, and the weaker it becomes. With a constant current through the system it might seem as if no variation in armature reaction were possible. By examination of Fig. 6 we find that although a constant current in the front brush has commenced to discharge, the field in which it is revolving having become weaker, and it is time to disconnect the segment. Then the breaking space should come into action or the potential of the back brush will be lowered. The back brush therefore carries current but never breaks the circuit, because when it leaves a segment the front brush rests on the same, and the two brushes are connected. As soon as the potential of the segment connected with the front brush drops, it is disconnected. In this way the back brush carries most of the current and does not spark. changes, shifts the commutator into a position calculated to change the magnetic axis of the armature and assist more or less the field magnet strength. This is shown in Fig. 10. If the load increases, the commutator must move into such a position as to increase the strength of the field. The weights fall in, the commutator moves backward and the resultant line forward. If we bring the *S* pole of the armature close to the *S* of the field, the armature would revolve either in one direction or the other, if it received a slight impulse. The more we move the magnetic axis forward, the more

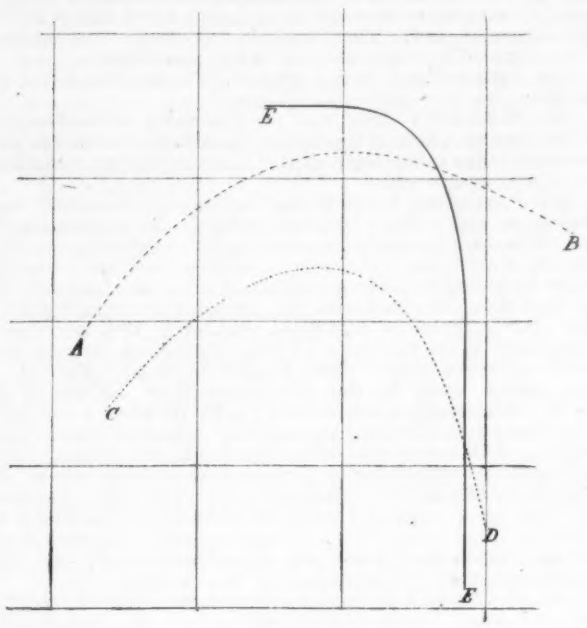


FIG. 1.

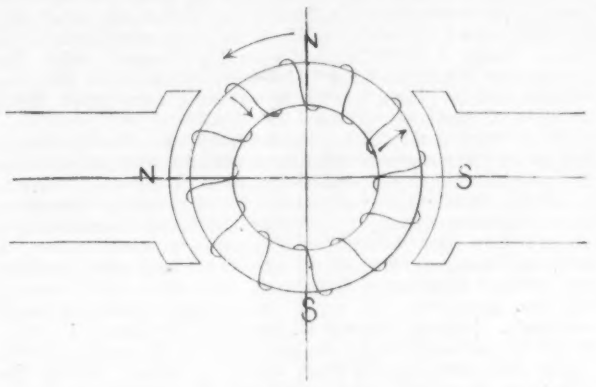


FIG. 4.

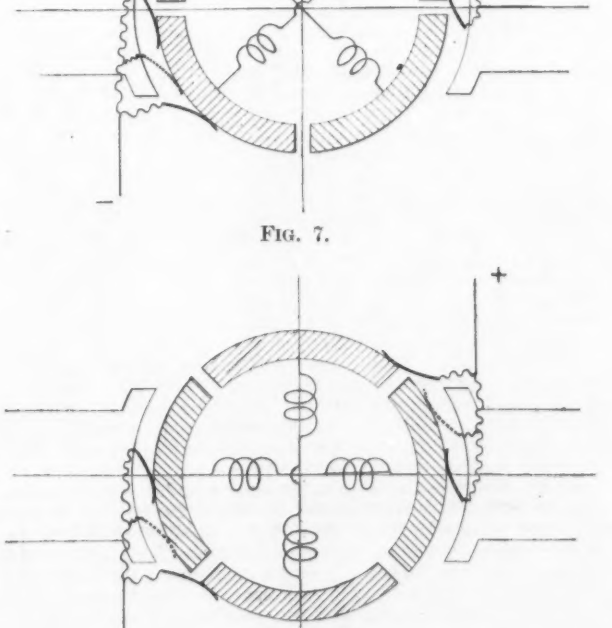


FIG. 5.

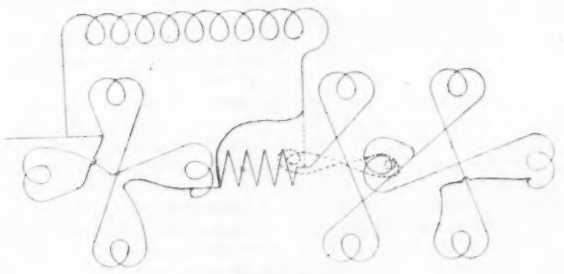


FIG. 6.

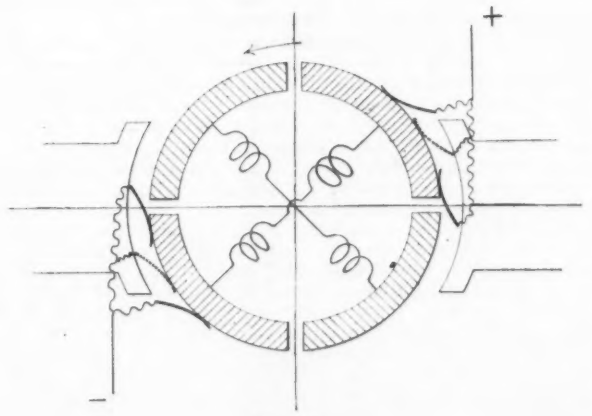


FIG. 7.

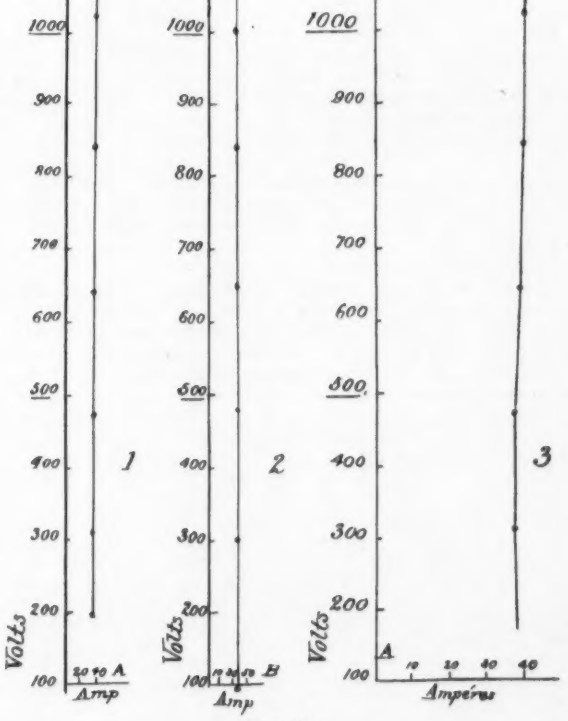


FIG. 9.

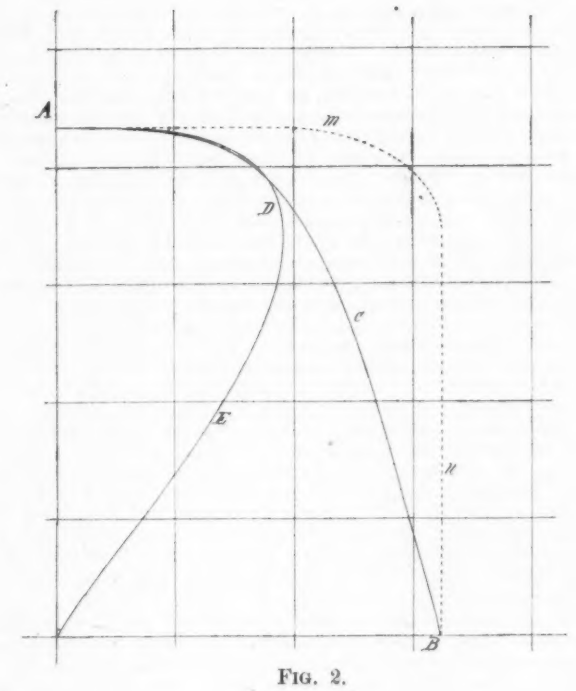


FIG. 2.

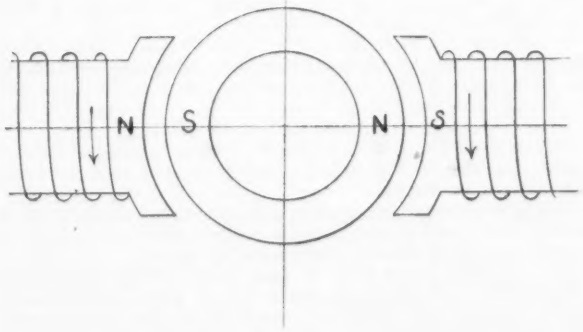


FIG. 3.

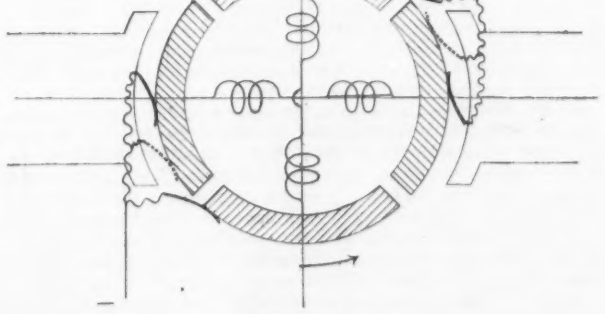


FIG. 8.

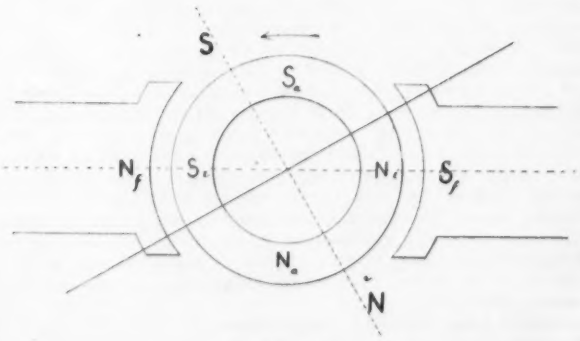


FIG. 10.

ROBERTS ON THE ELECTRICAL TRANSMISSION OF POWER.

flows in the outside circuit, it varies in the shunt according to the external resistance, and in such portion of the armature as is shunted. If the shunt is a long shunt, or partially so, the series winding will be affected. As a segment arrives at the back brush, see Fig. 7, the bobbin connected thereto is approaching the maximum field, and when it reaches the forward brush both brushes take current from the segment. When the breaking space arrives between the two brushes the forward brush rests upon the segment above considered, and the bobbin with which it is connected is passing into a weaker field. We have, however, a self-induced current in the bobbin, which desires to discharge itself and takes time so to do—this current will be in the same direction as the armature current. At first when one brush rests on each segment, the segments are at the same potential. Soon the self-induced current The spark upon the front brush is a thin spark without heat, the spark being evidently due to the self induced currents. To keep this spark at the minimum, an automatic shifting device will be used.

The mutual interaction of all these variables, which, in their turn, are modified by what are constants for any concrete machine, but are variables when the machine is designed, such as shape of poles, etc., is a very interesting study.

The working portion of the characteristics of this dynamo is shown in the diagram, Fig. 9; two tests are shown. The ampères and volts are on the same scale. When the scale for current is five times that for ampères, the result is shown by curve 3.

The motor used in this system is a Brush series wound motor controlled by a centrifugal governor which, when the speed work will it develop, until the armature magnetic axis reaches a vertical.

It is not necessary for the commutator to shift 90 degrees, as a shifting of the contact line acts as already shown, to still further shift the field.

The motor tested gave 84 per cent. efficiency at 70 brake h. p.; at 80 h. p. (the limit) it would have been somewhat higher. The efficiency must drop at lower powers, as the loss should be about a constant one. I did not have time to obtain figures upon this point.

The dynamo efficiency I cannot give, as I had no dynamometer of sufficient size available. Prof. Sylvanus P. Thompson points out that it is higher than with the motor, as in a motor armature. Fou cault currents are assisted by the current in the armature, and in a dynamo the reverse is true.

The striking points in the system are: A generator of great power, which cannot be injured by a short circuit; a motor which will not burn up if overloaded, but will stop working. The producer of current, therefore, is not called upon for twice the power represented as being used and for which the motor was sold, and then have to repair the motor to keep the trade. The system being a series one, every device in the circuit which utilizes the current adds to the efficiency of the system, as it decreases the percentage of loss in the wires.

My thanks are due to Mr. Brush for allowing me to obtain the foregoing figures, to Mr. Pfannkuche for his assistance, and to my assistant, Mr. Scheible, for rapidly preparing the diagrams.

The President: The paper is now before you for discussion. If there are no remarks, the topic will be passed with instructions to the Secretary to spread it upon the minutes.

Mr. Morrison: Mr. President, your committee beg to make the following report: We recommend Kansas City as the next place of meeting of the National Electric Light Association. We recommend further for the officers of the Executive Committee of the association the following named gentlemen: G. W. Hart, Kansas City, chairman; L. A. Beebe, Hutchinson, Kan.; J. A. Corby, St. Joseph, Mo.; B. E. Sunny, Chicago, Ill.; S. S. Leonard, Minneapolis, Minn.; C. R. Faben, Toledo, O.; P. H. Alexander, of New York; Frank Ridlon, of Boston; J. F. Morrison, of Baltimore. The vote was unanimous in the committee, except on the last name. (Laughter).

The President: Gentlemen, you have before you the report of the committee. What will you do with it?

Mr. Whipple: I desire to make an amendment to the report of the committee if that is in order.

The President: An amendment to the report of the committee will not be in order.

Mr. Whipple: You cannot prevent the motion—it is very important.

The President: Preliminary to that there should be a motion to adopt.

Mr. Lynch: I move that we adopt the report.

The President: It is moved and seconded that the report of the committee submitted through its chairman, Mr. Morrison, be adopted.

Mr. Whipple: I move as an amendment to that is not in order. I am very sorry that I am obliged to name a place which I hope this convention will meet in next time, which is not Kansas City. I have the honor, as well as the pleasure, to represent a city something like twelve or fifteen hours' ride this side of Kansas City, which is St. Louis. I am authorized by the Board of Directors of the St. Louis Exposition, to invite this association to hold their next convention in their building in February next. They have unlimited facilities there for the holding of this convention, and those facilities they offer to this convention free of cost. The facilities consist of unlimited horse power—something like 2,000 h. p.—and plenty of space and music halls in which to hold the meetings.

Mr. Duncan: As I understand, we are acting upon the report of this committee in regard to officers.

Mr. Whipple: There has never been a convention held at which the supply people who were members of the association have not been glad to pay for their space. We will give you the convention in St. Louis without expense to any one who attends the convention, so far as the convention is concerned. We will pay all bills of the convention. There will be no bills coming in on you afterward. We will take care of them all and give you facilities for making a good time of the occasion. I move to amend the resolution by substituting the word "St. Louis" for "Kansas City."

The motion was seconded.

Mr. Morrison: It is proper, that I, as chairman, should give you the reasons which influenced the committee in their recommendation. Mr. Whipple presented to the committee precisely the statement that he has given you, perhaps fuller, and the inducements to recommend St. Louis were so apparent that we were compelled to make further inquiry as to what would be the counter-inducements for Kansas City. Kansas City we thought of for two or three years past, and accepted as the meeting place of the Convention at a date to be named by President Weeks, when the authorities of that city were able to entertain and provide for the comfort and the necessary power and space required for the convention. St. Louis offered the Exposition Building, probably one of the finest and best equipped establishments of that kind in the country for holding just such meetings as we anticipate the next meeting of the association will be. They give you a meeting hall and 2,000 h. p. steam power. They give you every facility for holding the convention, and absolutely free of cost either to the association or to its members who go there to exhibit their wares.

Kansas City presents its case, first in a telegram from the Mayor addressed to the president of the association, in which he says: "I extend through you an invitation to the convention to hold their next meeting here. Exert every effort to bring the convention to Kansas City. Signed Joseph J. Davenport, Mayor." The conditions upon which we are invited to Kansas City are similar to those offered by St. Louis. The committee's judgment was influenced by one or two particulars which I will now mention. The hotel rate for this convention would be from $2.50 to $4 a day, which is very much lower than the regular rates in these hotels, said to be two of the finest hotels in the United States; one of four large halls, two of which are theatres, two of them halls capable of accommodating 500 or 600 people comfortably; power sufficient to drive any exhibit that may be placed there, not steam power but electric power, from any class of current or any system that the gentlemen may desire to use; constant current, alternating currents, the Edison system, the Brush system, and I don't know what others; but giving you the choice of any system you may desire for your apparatus—all this, free of cost.

In the St. Louis matter, we learn that the Exposition Building is some distance from the hotel. At Kansas City the Exposition Building and the meeting rooms are directly across from one of the hotels and diagonally across from the other, so it will be simply crossing the street to obtain access to the room. The proposition made by President Weeks is to this effect: That one hall shall be taken for the meeting room and one for the exhibition room. That the exhibition room shall be closed during meeting hours and open all the rest of the day.

These were the items that influenced the committee in its decision. We do not desire to make any extra recommendation. I have simply called your attention to the fact that Kansas City has been promised this meeting for several years, and the balance of the report is before you.

Mr. Russell: As there seems to be some question as to the location, I would like to say a word in favor of my city, St. Louis, and therefore will mention the accommodation, etc., of that city. The Southern Hotel is the largest in the country. The rate is there from $3 to $4 per day. What we can secure in case of a convention I do not know, but I know that during the Gas Convention there the rate was $3 above the second floor and $4 below. The Exposition Building is about ten blocks up from Fourth street, but there are two cable lines making the time in about five minutes. Besides, being one night less ride for Eastern parties, I think more people will come from the East, while more might possibly go to Kansas City from the West. Still I think all round, St. Louis being a little more centrally located, with the promise of the Exposition Building, and the fact that this exhibit will be given, I think it will be a very good thing to go to St. Louis.

Mr. Whipple: I did not intend to speak twice upon this; but as telegrams are in order, I would like to read one from the president of the Board of Directors of the St. Louis Exposition. Here is the dispatch: "Our Board of Directors have instructed me to invite the National Electric Light Association to hold their February convention in our building. We have all the necessary facilities for the meeting, and our citizens will extend to the members of such convention every possible courtesy. Signed, Samuel M. Bernard, President." In relation to the location, let me say that the Exposition building is just four blocks from the post office. Every one who has been to St. Louis and seen the post office knows that four blocks away from that building is not very far from the centre of civilization. For hotel rates, I am authorized to say that the very lowest hotel rate possible will be given, and that this convention will be treated as courteously as any convention ever has been there.

The President: The question is on the motion of Mr. Lynch to adopt the report of the committee—the question is on the amendment of Mr. Whipple to substitute the name Kansas City in the report of Mr. Morrison. (The Chair calls for the ayes and nays, and upon receiving the same stated that it was not decided. A rising vote was called for, and there were 14 in favor of the amendment, 13 opposed to it.)

The Secretary: Will the chairman of the Executive Committee take the count?

The President: The ayes seem to have it.

Mr. Morrison: I call for a recount of the vote.

Mr. Whipple: Mr. Chairman, how many times do we vote after the chair has decided a thing carried? The decision was that the amendment was carried.

Mr. Morrison: The gentleman is out of order.

The President: The gentleman is out of order, as the decision was not rendered. I think the position of the gentleman from Baltimore is correct.

On taking a rising vote the second time, there were counted 19 in favor of the amendment and 11 opposed to it.

The President: The ayes have it.

Mr. Morrison: Now, Mr. President, before a decision is rendered in this case, I want you to make one other decision; that is, whether we are operating under the new constitution or under the old one.

The President: Under the new constitution.

Mr. Morrison: Then the vote had now is null and void, because the vote is confined to active members.

Mr. Reed: Mr. Morrison himself has stated this constitution could not go into effect until February next.

Mr. Morrison: I have not. Many points about it do not meet with my approval. This convention to-day is a convention of supply men and not of central station men. But if you are acting under the new constitution the vote must be that of the central station men and does not include the supply men. At the Chicago convention you stood upon the eve of a disruption, and it is for that reason that I have risen here. I came here for a peaceful solution of these questions. These supply men were recognized in the appointment of a committee for the revision of the constitution. That report has been unanimously accepted by this association. The matter was settled at Chicago. It was referred to the committee, correspondence was carried on, and hundreds of letters have been received from the concerns who employ gentlemen representing their interests on this floor to-day, and who, as I understand, were unanimous in their approval of the subject which the constitution recommended: that the voting power of the National Electric Light Association be confined to the central station men and a fair representation given to the supply men. You received that constitution, you adopted it, and you are the men whom it affects. I would not have objected to the supply men as members. I would have taken my chances with you. My relations with the supply men throughout the country have been most friendly. It was only for the purpose of selfish ambition that unworthy men sought to disrupt you. I was willing to take my chances until yesterday. Under the constitution which you have adopted, there is not a single man who stood up there among that gallant band of 19 who has a right to vote on this question. I call for the Chair to make a decision in this case. If he decides that your action is null and void, the vote will have to be decided by the central station men, and by them a decision must be reached. In presenting this motion I presented it in good faith. I objected to my name going on the Executive Committee. For some reasons, the association has given me honors I did not desire. I have striven to discharge my duty always in whatever position I am placed; and when you make laws, I insist that you shall abide by the provisions of those laws; when you adopt a constitution, I insist that you shall live up to that constitution. You did not even give Mr. Lynch the opportunity of taking up your constitution *seriatim*. You could then have made the changes you desire; you could have done the same thing that you are talking about now. You shut the door yourself. After you have made a bargain (and I have known many of you to make bad bargains and stand by them, filling contracts with me for wire after the price had advanced), you should stand by it.

Mr. Reed: I have no choice at all between these two cities. I would just as lief go to one as to the other. The question that I would like to ask is as to whether the President decided that this constitution is binding upon this association at this time, at the moment of the acceptance—not the adoption—where no chance was given for discussion upon this important subject; and if we people are kicked out and told, "We will take your brains and your money, but we do not want your vote," I want to know whether that is admitted now, or whether it does not take effect until next year, as Mr. Morrison himself decided yesterday it would.

Mr. Morrison: Mr. President, allow me to say that we have not kicked the gentleman out. We have not done anything of that kind. We all want to keep you in. You have kicked yourselves out. You adopted the constitution which bars you out.

Mr. Reed: Excuse me, but there has been no adoption here yet.

Mr. Morrison: A play upon words, Mr. Reed. You simply took the other word, which means the same thing. I believe that that constitution was the work of the supply men. Their vote said it was acceptable, and they unanimously adopted or accepted it, and they have made it the fundamental law. The Chair has declared that we are operating under the provisions of this constitution.

Mr. Reed: There was a protest. It was ruled out of order.

Mr. Morrison: There was no discussion, and when the Chair announced that this is the constitution there was not a single voice raised against it. There is your constitution, it is your own work.

The President: I greatly regret that this discussion has arisen, as I took this whole movement in the kindest spirit, as originating among those members of the association who are most affected by the proposed action, and the committee who submitted this amendment—three of them belong to that class; the chairman, Dr. Moses, Capt. Candee and Mr. H. D. Stanley—and these sentiments that have been expressed upon the floor of this convention surprise me and pain me more than I can express. But as I am called upon by the gentleman from Baltimore to decided the point raised by him, I must do what I consider my duty, and I decide that the point raised by him is well taken. This report was submitted to this convention. An opportunity was given for discussion and amendment. It was moved to accept. This was carried, and the decision of the Chair is that this is the Constitution of the National Electric Light Association. I regret, gentlemen, more than I can express, and I know you will all believe me, that this matter has come up as it has.

Mr. Whipple: The subject has become so diversified that I do not know hardly which point to talk on. Mr. Morrison has hurled some charges over in this direction. I am not connected with either faction. I know nothing about any faction.

Mr. Morrison: My remarks included Mr. Whipple with the rest of the gentlemen who are not actually engaged in electric station lighting.

Mr. Whipple: Now we have it definitely. Let me say that it was not we who adopted the constitution; it was not we who had a chance to express our sentiments upon that constitution. We had no opportunity at all. The attempt was possibly to stifle any discussion at all. That point was carried out very well. But, Mr. Chairman, are we here as a set of fixtures, or are we here for fair play? And shall the sentiments of those that are here be stifled? Irrespective of where this convention goes, there is a much more important question for this convention to decide, and that is whether the major portion of the people attending this convention shall rule, or whether a few men shall. We have taken two votes upon the question of St. Louis, and St. Louis has carried it by a very large majority. Why was not this situation stated beforehand, so that we would know how we stood? Are we to have one constitution to-day and another to-morrow? If Kansas City had got the vote would this question have been raised? I do not think it would. I do not think it is right, gentlemen, and I do not think it is legal the way the constitution is adopted. I had a very simple amendment to offer this morning. It was an amendment I had spoken of to nobody. It was a very simple thought of my own. I had no opportunity to present the amendment to the people here. Mr. Brown got up and said that his word was "accept" instead of "receive." But the chair did not put the motion. I will venture to say there are not five men in this room who voted for that constitution; on the other hand, the constitution under which you were then laboring stated that a two-thirds vote was necessary to adopt a constitution.

Mr. Lynch: I rise to a point of order. I think this discussion is very much out of order. The Chair was asked to give a ruling in regard to the constitution, and decided that the new constitution would hold. My object now is to object to the ruling of the chair on this particular thing.

Mr. Whipple: I entered into a contract with this association last February, by which I paid $20 for certain privilleges. What right has this association to violate that contract?

Mr. Lynch: I object to this discussion.

The President: The point taken by Mr. Lynch is well taken.

Mr. Godfrey: I voted for it with the understanding that the report was to be received, which was the word that Mr. Brown used.

Mr. Brown: I used the word "accept" and used it understandingly. The Chairman made the correction, and stated the question correctly. I just wish to put Mr. Whipple and the others right.

Mr. Lynch: I still rise to a point of order.

Mr. Godfrey: I ask to have the stenogpapher's notes read. The report was to be received, and I ask to have that vote reconsidered.

Mr. Lynch appealed from a decision of the chair upon a ruling that the new constitution takes effect at once. It was seconded by Mr. Blackwell, of Vermont.

Mr. Candee: I am one of that unfortunate committee being raked over the coals, and while I think this discussion is entirely out of order, I want to say that every member of the association has received a circular regarding the by-laws. To these we received answers to 105, 71 in favor of the constitution adopted. It was not one of our own make, but that of a majority of the letters received. Outside of that there are no amendments, and nothing additional or new. We thought that we were simply expressing the opinion of the association, and of the supply and central station men.

Mr. Morrison: I call for the regular order of business, and the vote as provided by the constitution on the question of the next place of meeting.

Mr. Lynch: I object. There is a motion before the house.

The President: I understood Mr. Lynch to withdraw that motion,

Mr. Lynch: No, sir; I did not withdraw it.

At this juncture, the president requested Mr. Morrison to take the chair.

After taking the chair, Mr. Morrison inquired for the gavel.

The CHAIRMAN: What is the business now before this Association?

Mr. LYNCH: The question is upon a ruling as to whether the new constitution—if I am wrong I would like to hear from the members of the association—whether the new constitution shall be interpreted to affect this association from the day of its adoption.

The CHAIRMAN: The appeal from the decision of the chair is not in order. The contitution is adopted and is before you for your pleasure. Mr. Secretary, what is the next regular business before the association.

The SECRETARY: Mr. Chairman, there is no business in the hands of the secretary as far as he knows—there is no next order of business.

The CHAIRMAN: We will proceed then with the adoption of the report of the committee. Are you ready for the question?

The chair put the question and declared it carried, and the report adopted.

Calls for division.

The CHAIRMAN: The decision of the question is made, and no division can be called for after that. As there is no regular business before the association, there is nothing left to do but to entertain a motion to adjourn.

The motion to adjourn was put, seconded and carried, and the convention then adjourned *sine die*.

The following report was presented by Mr. B. Rhodes, chairman:

REPORT OF THE EXECUTIVE COMMITTEE.

Your executive committee, appointed at the Chicago convention, was so scattered throughout the country that it was found too inconvenient and expensive to have meetings of the entire committee; therefore, the various matters of interest were delegated to sub-committees, who have united to make this report.

One of the most important matters before the committee was the establishment of a permanent headquarters in the city of New York. The experiment has been tried a few months, and at the Chicago Convention it was ordered to be continued six months more. Your committee have moved the office from Twenty-third street to the elegant telephone building No. 18 Cortlandt street, in the centre of the electrical business district, and convenient for both resident and non-resident members.

The work done by the secretary at this office shows itself in the largely increased membership of the association, and in the work of the various committees which have reported at this convention. The committee have no hesitation in saying that the success of a permanent headquarters has been in advance of their expectations, and earnestly recommend that the New York office be continued.

The volume of proceedings of the Chicago Convention has been made up in better form than heretofore, and the cloth binding changes the pamphlet, which may be thrown into the waste basket, to a book worthy a place in any library. Members have heretofore been limited to a single copy of the proceedings, but your committee have provided that hereafter further unbound copies, to a reasonable limit, may be supplied to members without charge, and the binding may be added to the current or previous volume at cost.

Your committee are glad to be able to present a good report as to the finances of the association. The year 1888 closed with a debt of $1,800. The debt has been entirely wiped out, with the single exception hereinafter referred to. The entire expense of the current year to Aug. 1 has been paid. There are no outstanding bills, and a balance remains in the treasurer's hands of $910. The income of the association for the calendar year will be over $5,200; the expenses about $1,000 less. So that your committee can say with some confidence and much satisfaction, that the association is in a sound financial condition. There is, as just mentioned, one claim against the association still unpaid. The amount is $259.60. This was incurred before the appointment of this committee, therefore the payment is considered beyond its jurisdiction. There is no doubt whatever that it was incurred for the benefit of the association, and your committee recommend that authority be given them for its payment. The preparation for this convention has been part of the labor of this committee. The character of the papers presented is such that the report cannot but add to the growing influence of the association.

The question of exhibit has been a perplexing one. The exhibit of Chicago grew to such large proportions that any exhibit at this convention was discouraged. It was found, however, that some exhibitors are members and pay dues solely for this purpose, and others have novelties brought out since the last convention. Therefore, while a large exhibit has not been encouraged, it has been left to the members. with the proviso that there should be no expense in the matter to the association. This matter of exhibit is one that will call for careful consideration by future committees.

In this connection, your committee wish to express thanks to the Niagara Falls Hydraulic Power and Manufacturing Company and the Oneida Community, Limited, for unusual courtesies extended during the Convention.

The following resolution has been approved and adopted by the Executive Committee:

We, the undersigned, a sub-committee of the Executive Committee, appointed for the purpose, beg leave to report the following, as embodying the views of the Executive Committee:

WHEREAS, It is extremely important that the United States census for 1890 should contain a special section for the electrical industry, and that the data for such section should be collected, tabulated and published in a thorough and systematic manner,

Resolved, That the National Electric Light Association now in convention, respectfully request the Superintendent of the United States Census for 1890 to provide a section for the electric industry, and they would suggest that Mr. Allen R. Foote, of Cincinnati, Ohio, has proved himself to be well qualified to do this work, and that he would be a proper person to organize and direct it.

(Signed) EDWIN R. WEEKS,
OTTO A. MOSES,
T. CARPENTER SMITH.

NOTES.

About sixty towns and cities were represented at this convention.

One very pleasant feature of the meeting was the large attendance of ladies, many of whom could thus, for the first time, gratify their natural curiosity as to the manner in which the association does its work, and also see Niagara at the height of its summer beauty and majesty.

A "social reception and promenade concert" took place at the International Hotel on Wednesday evening, under the auspices of the association. The irreverent called it a "hop." Under whatever name, it was a most agreeable affair, and everybody participated. Messrs. Fred. Whipple and J. W. Godfrey were chosen floor managers by unanimous voice, and they acquitted themselves in a most creditable manner. Dancing was kept up steadily till about 1 A. M. Even then there were some who were not satisfied, but who insisted on singing songs and tripping the l. f. until three.

On Tuesday evening a charming excursion was given by Mr. Rhodes to Lewiston in the observation train, and two or three hundred ladies and gentlemen enjoyed the beautiful view of the Niagara River by moonlight. It had also been hoped to take a sail on the lake, but as the large steamer was not in service, and the smaller one could not accommodate the unexpectedly numerous party, Mr. Rhodes wisely determined not to make the venture. The train returned to Niagara Falls about 9:30, and the roar of the cataract was outdone by the expression of the musical sentiment that "Rhodes is a jolly good fellow, which nobody can deny."

EXHIBITS.

C. A. Hitchcock, North East, Pa., exhibited a cell of the Burnley dry battery.

M. E. Baird looked after the interests of the Eddy Electric Mfg. Co., of Windsor, Conn.

The Perkins Electric Lamp Company, of Chicago, were well represented by Mr. W. G. Halm.

Henry Reed, of the Bishop Gutta Percha Company, New York, had a pocketful of handsome samples.

The McIntire electric wire connectors and terminals were nicely displayed by C. McIntire, of Newark, N. J.

The Western Electric Company were adequately represented by Mr. C. A. Brown and Col. Geo. Beetle.

J. W. Godfrey, New York, was on hand, as usual, with samples of the only "Grimshaw White Core" wire.

The Western Valve Company, Chicago, showed samples of their steam specialties, with asbestos disc fittings.

Fairbanks & Co., Boston, represented by E. B. Williams, had a display of their vulcabeston insulating material.

The merits of P. & B. Compound were strongly represented by P. H. Hover, of New York—without opening the can.

Did you secure a copy of "Electrical Power Transmission" for your library from the Brush Electric Company's exhibit?

F. E. Pritchard, Cedar Falls, Iowa, described the merits of his water-wheel governor, for Niagara and smaller powers.

Mr. Emil Gabel, of New York, looked after the Eastern interests of the Charles Munson Belting Company, and with marked success.

Henry S. Thornberry & Co., of Toronto, were represented by their principal. They are busily engaged as contractors for electrical work.

The Simplex Electrical Company, of Boston, while making no display, had able representatives in Messrs. Pond, Mason and Cutter.

W. P. Seymour, of Syracuse, N. Y., had a number of his universal carbon holders in the exhibit of the Standard Carbon Company.

The Globe Carbon Company, Cleveland, O., represented by J. S. Scoville. while having no weightier exhibit were taking care of orders.

The Ellis Lubricator Company, Boston, had various sizes of cylinder and air-compressor oil cups on exhibit. Mr. S. Holbrook was in charge.

Prof. Aron's electric current counter, manufactured by W. Hackenthal, of New York, was shown to advantage by Manager A. Barthman.

C. H. Rudd, of Chicago, exhibited an automatic ground alarm that is operated by induction, and designed principally for arc circuits.

Bickford & Francis, Buffalo, N. Y., showed a belt 56 inches wide by 133 feet long made for the Brush Electric Light Company, Buffalo.

P. C. Ackerman's case of the beautiful cords, flexible wires, etc., of the American Electrical Works, had a salty, clam-like fragrance about it.

Mr. S. E. Cox, of the Brush-Swan Company, Cleveland, was in full accord with everything tending to increase the incandescent lamp business.

The interests of the Standard Underground Cable Company, Pittsburgh, were cared for by Fred Degenhardt, of Chicago, and Mr. J. W. Marsh.

S. Rosenstamm talked up the bare Lake copper wire handled by Lewisohn Brothers, New York, the conductivity of which is highly spoken of by users.

The Franklin Electric Company, 120 Randolph st., Chicago, had space, but no exhibit other than a card referring to the manufacture of fine instruments.

The Falls Rivet & Machine Company, of Cuyahoga Falls, Ohio, exhibited a new form of clutch pulley. Mr. E. L. Babcock and C. D. Schmitt were present.

The Underwood Manufacturing Company, Tolland, Conn., were represented by O. H. Merrill, of New York, who showed some handsome samples of belting.

John A. Roebling's Sons Co., Trenton, N. J., were well represented by W. E. Frick and Frank C. Dumas, who showed samples of their new weatherproof wire.

The Butler Hard Rubber Company, New York, represented by their treasurer, G. R. Turnbull, showed some handsomely finished hard rubber storage cells.

W. W. Castle exhibited samples of wood conduits saturated with P. & B. Compound as manufactured by the P. & B. Conduit and Construction Company, New York.

Pettingell, Andrews & Company, Boston, would have had a handsome exhibit had their samples not been delayed en route. Mr. Pettingell represented the house.

The Chas. Munson Belting Company, Chicago, had the irrepressible J. H. Shay as their exhibit. He said that their factory cannot keep up with orders for rawhide canes.

The Okonite Company, of New York, were well represented by Capt. W. L. Candee and George Manson, and their insulated wires and cables found many admirers, as usual.

J. F. Kelly, like the white-plumed knight he is, had his armor on and his lance in rest for the big Edison Machine Works, whose trade in wires and cords, he says, was never larger or better.

The Graphite Lubricating Company, of Jersey City, N. J., had their best man, W. H. Bache, on active duty explaining the merits of the anti-friction bushings, journal bearings, etc.

The American Leather Link Belt Company, of New York, were well represented by Secretary G. H. Fisher, who placed two 16-inch belts on the Brush plant in the local station.

The representatives of the National Carbon Company were kept busy handing out the new edition of their directory of arc light companies. Webb C. Hayes, Benjamin F. Miles and C. D. Smith, of Cleveland, were present.

Robert M. Gardiner, of the Hamilton, Ont., Electric Light Company, exhibited an inside globe guard designed to prevent the cracking of arc light globes from falling pieces of heated carbon, etc.

Actual results in the saving of fuel was what Jarvis B. Edson, of New York, talked about, with an abundance of cold facts to prove his assertions true as to the value of his recording apparatus.

The Anti-friction Metal Company, Northeast Pennsylvania, showed samples of their tempered copper boxes for the bearings of high-speed electric machinery. Mr. A. L. Daniels was in charge.

The Non-Magnetic Watch Company of New York, represented by C. R. Batsford, had a valuable exhibit of the Paillard non-magnetic movements in cases, ranging in value from $8 to $1,200.

The Ansonia Brass and Copper Company, Ansonia, had Gilbert W. Smith, manager of the Chicago office, on the ground fully equipped for the fray, with handsome samples of their new waterproof wire.

Mr. J. A. Pentz exhibited the excellent Pentz-Reckenzaun meter, that has already been illustrated and described in the columns of THE ELECTRICAL WORLD. It deservedly attracted a good deal of attention.

The American Indurated Fibre Company, Mechanicsville, N. Y., exhibited samples of indurated fibre pipe specially made for underground work and designed to carry either water, gas, or acids, or to hold electric light wires. Mr. Coleman represented them.

The Washburn & Moen Manufacturing Company, Worcester, Mass., had a handsome sample board of iron and copper wires and cables on exhibit. The Western Electric Company have the exclusive sale of their wires to electric companies.

The Phœnix Glass Company, of New York, furnished the beautiful globes and shades on the lamps around the gallery front of the Casino meeting room. But everybody wanted to know what had struck Patterson that his genial face should not be seen.

C. A. Schieren, Jr., Mr. G. H. Fisher and E. A. Atkinson, of New York, represented Charles A. Schieren and Co., of New York, with a neat display of their belting, and distributed a handsome souvenir showing views of their factory and their process of manufacture.

Matt Goodyear, a veteran of the electrical industry, finds a host of new friends in the electric lighting field. He can speak for electricity in the days when the electric light was not, and also for it to-day when the E. S. Greeley & Co. have more than they can do to keep pace with orders from local lighting companies.

Walter T. Wilson, Buffalo, N. Y., represented the New York Phonograph Company, and had an Edison phonograph and a Bell-Tainter graphophone on exhibition, as usual, constantly surrounded by a crowd of visitors eager to hear the reproduction of their own dialect. David H. Darrin, of Buffalo, was in charge.

Jas. W. Queen & Co., Philadelphia, had their usual interesting display of fine testing instruments. R. O. Heinrich was in charge, and called attention to the exceedingly fine workmansh p apparent in all their goods and which is worthy of much commendation. A new instrument that attracted much attention was the Heinrich station ampère meter, designed for either alternating or constant current.

The Sawyer-Man Electric Company exhibited their new double carbon lamp and their new series incandescent lamp and socket especially designed for arc light circuit. In case of the failure of this series lamp from any cause it is instantly cut out by the fusing of the plug placed in the thumb piece. F. E. Alexander and H. S. Barney destributed copies of two valuable works covering the subject of electricity and supplies.

The Solar Carbon and Manufacturing Company, Pittsburgh, Pa., had a well-devised sample board showing all the products of their factory, from a carbon brush for electric motors to a carbon rod—made for the Cowles electric smelting process—that is three inches in diameter by fifty in length. They also exhibited the carbon cups made expressly for the Gassner dry battery. H. E. Webb, Pittsburgh, was in charge of the exhibit.

The E. P. Gleason Manufacturing Company, New York, aside from their exhibit in the Casino, had an interesting display in the International Hotel, consisting of richly engraved and etched, as well as plain glassware for incandescent or arc circuits, also samples of their new gas attachment, electric holders for all systems, etc. W. F. Cullen, who has attended the different meetings, represented them here in his usual convincing manner.

It is worthy of note that the Niagara Falls issue of the *Bulletin of the National Electric Light Association* constituted its seventh series, and that at the various conventions held, some 50,000 copies of it have been gratuitously printed and distributed by THE ELECTRICAL WORLD for the convenience and information of members and their friends. At the Niagara Falls meeting, in a place where the facilities are so limited, the difficulties of issuing the bulletin were unusually numerous; but the obstacles were overcome, and the bulletin was put forth in good shape, with all the convention news of interest.

The Excelsior Electric Company, of New York, represented by Mr. D. Hyman, placed a 100-light incandescent Excelsior dynamo in the Casino, and were operating it by a 10 h. p. Excelsior motor, the current for same being obtained from the local Brush station. The various lamps were distributed mainly to represent the words "Excelsior Light." A new Heinrich station ampère meter was located in the circuit. A 3 h. p. motor was also shown. The whole exhibit was a very striking one.

The Standard Carbon Company of Cleveland had on exhibition cases of arc light carbons and a sample board of carbon rods, plates, etc., designed for almost every purpose for which carbon is used. Carbon rods, 52x3 inches, for use in smelting; carbon plates for battery purposes; carbon brushes as supplied to the Sprague and other railway systems were shown, also samples of the coke and pitch used in their manufacture. Messrs. Crouse and Tremaine were in charge.

The Brush Electric Company, of Cleveland, erected a building near the Casino and ran therein one of their new 1,000-light alternating machines by an 80 h. p. Brush motor, the current being supplied from a generator in the Oneida

Community building. From this little station extended wires to and around the assembly room, where some 580 plain and colored incandescent bulbs were lit up. The converters were placed at the rear of the stage, but in full view of the audience. A 3 h. p. motor was also in operation. Two Schieren "electric" belts connect dynamo and motor. The gentlemen in charge are G. Pfannkuche, C. F. Wright and W. S. Culver.

The Bernstein Electric Company, of Boston, represented by Mr. H. B. Cram, has a splendid exhibit of its series incandescent lamps in actual use on an arc light circuit. The current is furnished by the local arc plant, and the lamps burn all the time, shaming the daylight, being well distributed throughout the exhibition rooms. In the evening their soft beams beautify the piazzas and porch of the sombre International Hotel where the delegates congregate. The exhibit shows the variety of uses to which the company have adapted their series lamps. At the entrance to the Casino on either side of the door is a neat and attractive street fixture; and within the building are the various styles of fixtures used for interior lighting, including single and double brackets and pendants, or electroliers and portable stands, which, being attached by flexible cords, may be used wherever desired. One of these cords runs clear across the hall, carrying current to a 25 c. p. lamp enclosed within the Washburn & Moen show case. Mr. Cutter, the Western representative, is also here.

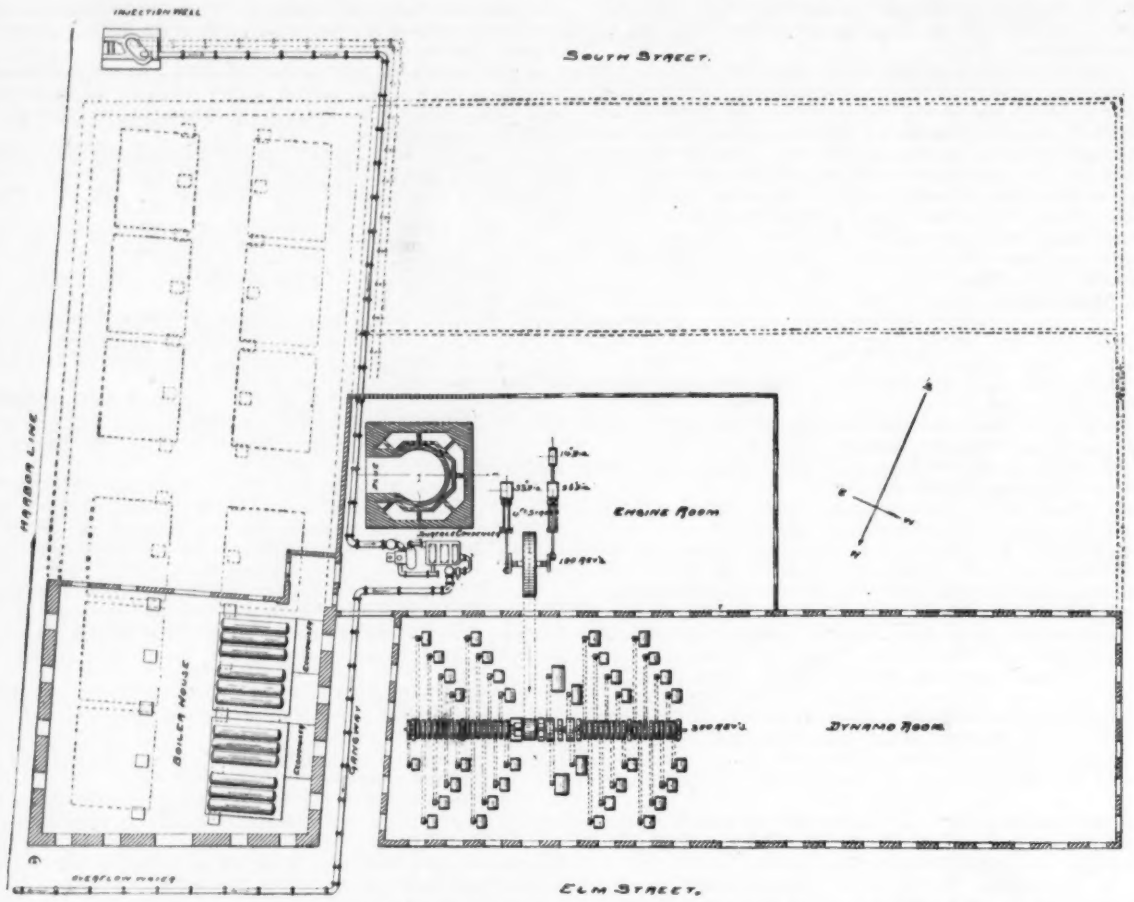


FIG. 1.—PLAN OF NARRAGANSETT COMPANY'S STATION, PROVIDENCE.

The New Central Station of the Narragansett Electric Lighting Company, Providence, R. I.*

BY J. T. HENTHORN AND C. R. REMINGTON.

It is without doubt generally conceded by the managers of electric lighting stations that the main, if not the vital, practical problem ever present for their consideration is how best to reduce the cost of the running expenses of the station. We state this advisedly, because the stage of doubt and uncertainty, coupled with experiment, has long since passed, and the business of producing electricity commercially is one of the leading interests of to-day, not only in this country, but in the world at large, and is being rapidly extended. The reasons why it is so desirable to lessen the cost of the production of electricity will readily suggest themselves to the practical mind. We would, however, venture the opinion that one, but not the least one, may be found in the desire to increase the earnings which are returned to the stockholders with more or less frequency in the form of dividends. In view of this condition of things pertaining to matters electrical at the time to which our attention was attracted to this subject, we at once gave the matter serious consideration, and came to the conclusion that for the present, at least, the most needed and radical improvements should bear directly upon the steam plant and also upon the mechanism employed in transmitting the power thus generated to the dynamos. At or about the time to which we have just alluded, M. J. Perry, Esq., the efficient general manager of the Narragansett Electric Lighting Company, of Providence, R. I., commissioned us to design and plan the arrangement of the entire motive power and machinery, as well as the buildings and chimney necessary to the completion of a proposed first-class electric lighting station, which might be expanded to an ultimate capacity of some 12,000 h. p.

The site for the new station is on the west side of the Providence River, and just north of the Point Street Bridge. The lot comprises some 55,000 square feet of land, bounded on the north and south sides by public streets, and a water front forming the east side. In the preliminary plan (which was afterwards adopted) the new station was represented as having two dynamo buildings, each 60 feet by 200 feet—one on each street—the number of dynamos to be provided for in each building being about eighty, of an average capacity of fifty to sixty arc lights; the dynamo-houses being united along the west side end by a building used for offices, storehouses, etc. The dynamos are so arranged that a much greater number than usual are located in a given floor space. Notwithstanding that this statement might lead one to infer that the machines are too compactly placed, there is still left ample room for ready adjustment, inspection, etc. All the dynamos in each building are driven direct from pulleys rigidly secured to a main line shaft located below the dynamo-room floor. It will be seen that this arrangement of buildings forms a hollow square, open on the east side. In this space, which is covered by a well lighted and ventilated roof, are located the engines.

In view of the fact that the employment of the best type of compound engines is being constantly extended to effect a considerable saving of steam (or fuel), it was decided to adopt for the station triple expansion compound engines, provided with independent surface condensers and circulating pumps, the initial steam pressure being 160 pounds. As the lot has a water frontage of sufficient depth to allow vessels to lie alongside, it was decided to locate the boiler-house on that side, the plan being to discharge the coal from the vessels directly into coal pockets of large capacity built into the roof of the house, from which, by a series of suitably arranged chutes and pipes, the coal is delivered by gravity to the front of the boilers. The water-tube type of boiler was selected as possessing greater advantages over other styles of boilers, and also from the fact that a working pressure of 160 pounds would be required. To the rear of each battery of boilers is located, in the main flue, an economizer for increasing the temperature of the feed water. By means of short branch flues provided with dampers, the economizer may be cut out as desired and the waste gases pass directly to the chimney. It is the intention to introduce mechanical stokers soon. When thus equipped the labor required to handle the fuel will be reduced to a minimum. The chimney is made sufficiently large to produce ample draught for the entire series of boilers. It is located directly west of the boiler-house, and adjacent to it, and extends through the engine-house roof. The size of the flue itself is 14 feet in diameter, and it runs 235 feet high above the engine-room floor. By means of machinery, etc., thus outlined, together with others of special design, all of which will be hereafter described, it is confidently expected that the actual cost of the mechanical generation of electricity will be reduced to a lower figure than any other station having substantially the same capacity.

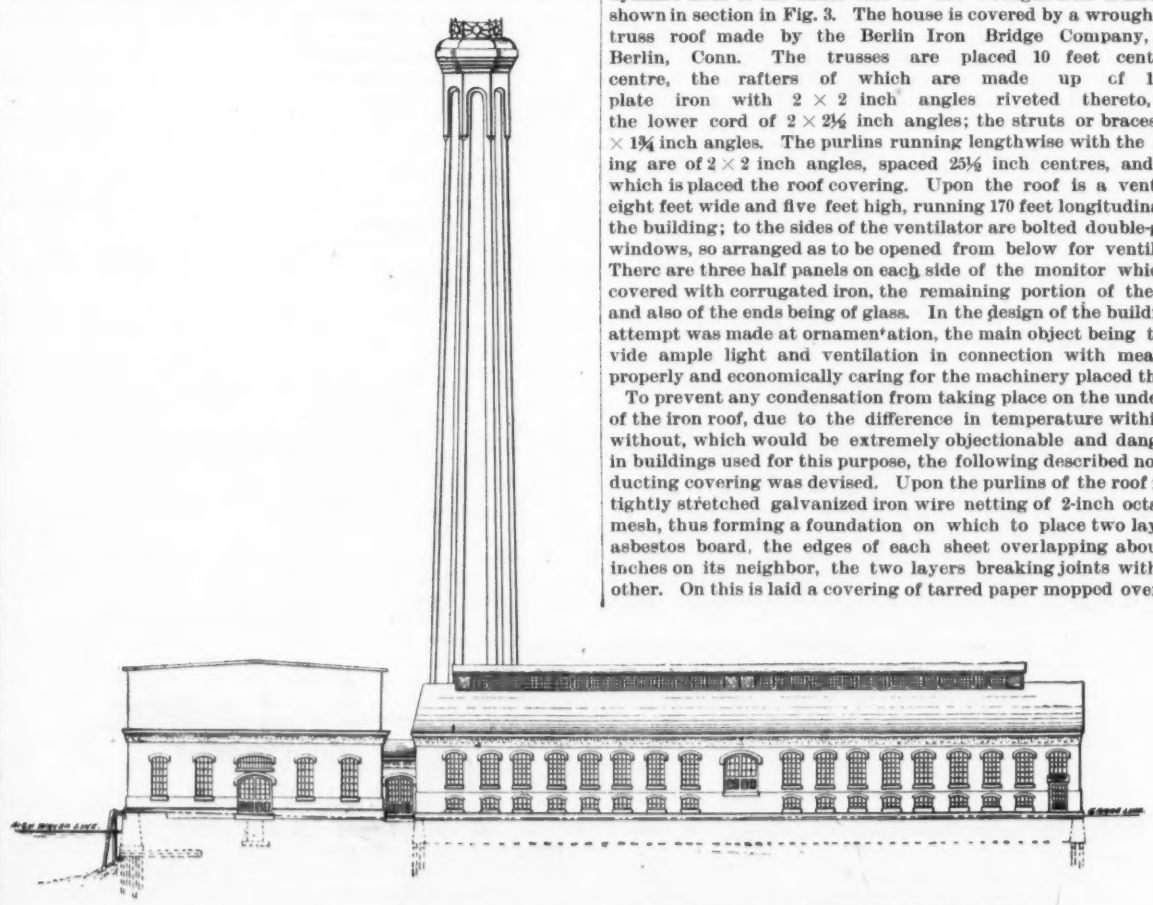


FIG. 2.—FRONT ELEVATION OF NARRAGANSETT COMPANY'S STATION.

The buildings constructed thus far, and what were deemed of sufficient capacity for the present with a large margin for growth, are a dynamo house 200 feet long and 60 feet wide, facing on Elm street; a boiler house 71 feet 10 inches wide inside, and 68 feet long, running lengthwise, and directly on the Providence River, which is of ample capacity to develop 4,000 indicated horse-power by the engines, and an engine house 57 feet wide and 110 feet long. These structures are of brick, of plain design, having granite underpinning and brown stone sills for the windows, and may be considered practically fire proof, as the only wood entering into their construction is that of the window frames and floor. The chimney, although not as yet finished, is of 14 feet internal diameter, 28 feet 6 inches square at the base, and 238 feet high from high water line. This structure alone will require 1,500,000 bricks. These structures are shown in elevation on Fig. 2.

The plans of these several buildings are shown in Fig. 1, and are represented by full lines, while the dotted lines represent a similar building upon the South street side, with an engine room intervening, ultimately to be 73 feet by 200 feet long in the clear without any posts, and the boiler house extended the full width of the lot, or 71 feet 10 inches by 200 feet when eventually carried out as necessity demands. It will, therefore, be seen that ample provisions for extension have been made, and which may be carried out without in any way interfering with the regular daily operations of the station or undoing what has been done on the permanent structures. The end and side wall of the engine house and also the end of the boiler house are of a temporary nature, although built of brick.

Dynamo House Foundations.

The character of the foundation which we had to deal with through all of the work of construction was that which one would naturally expect in dealing with a public dumping-ground, which, while forming a very solid upper crust, was overlaying a strata of dock mud and blue clay, which, when once entered, was as unstable as oil; underlying this was sand, and finally hard pan was reached at a depth varying from 35 feet to 50 feet below high water. The unreliability of this material determined that piling should be driven for all of the permanent walls of the buildings; and the specifications for the dynamo house foundations, which were the first started upon, were so drawn that piles of 30 feet in length, increasing toward the river to 45 feet in length, should be driven; and the whole, which were of spruce, and each being 11 inches diameter, were cut off 36 inches below established high water. These piles 216 in number, were driven alternately in two rows 32 inches centre to centre at right angles to the wall, and 64 inches centre to centre parallel with the wall, each row being surmounted by 12 inches by 12 inches hard pine timber pile caps. Upon these caps was started the masonry wall, 4 feet 3 inches wide at the base, tapering to 24 inches at the top on the four-foot level above high water. This wall was, as for all others laid in cement mortar in the proportion of one cement to two of sand. The assumption as to the length of the piles to be driven proved, from the nature of the surroundings, to be correct, as, when driven at the farthest or west point from the river, hard pan was reached at a level of from 35 to 38 feet below mean high water, and from this point toward the shore the strata gradually dipped to a level ranging from 50 feet to 53 feet below high water.

Dynamo House.

The walls of the dynamo house are, as before stated, 60 feet wide in the clear, and 200 feet long, and are 20 inches thick from the foundation up to the level of the dynamo floor, which is about 7 feet 9 inches above the average grade of the sidewalk; thence it is reduced in thickness by a pressed-brick belt course to 16 inches, and carried up to the 29 feet 3 inch level, thus leaving 17 feet from the dynamo floor to the under side of the wrought-iron trusses, as shown in section in Fig. 3. The house is covered by a wrought-iron truss roof made by the Berlin Iron Bridge Company, East Berlin, Conn. The trusses are placed 10 feet centre to centre, the rafters of which are made up of 10-inch plate iron with 2×2 inch angles riveted thereto, and the lower cord of $2 \times 2\frac{1}{2}$ inch angles; the struts or braces are $2 \times 1\frac{3}{4}$ inch angles. The purlins running lengthwise with the building are of 2×2 inch angles, spaced $25\frac{1}{2}$ inch centres, and upon which is placed the roof covering. Upon the roof is a ventilator eight feet wide and five feet high, running 170 feet longitudinally of the building; to the sides of the ventilator are bolted double-glazed windows, so arranged as to be opened from below for ventilation. There are three half panels on each side of the monitor which are covered with corrugated iron, the remaining portion of the sides and also of the ends being of glass. In the design of the building no attempt was made at ornamentation, the main object being to provide ample light and ventilation in connection with means for properly and economically caring for the machinery placed therein.

To prevent any condensation from taking place on the under side of the iron roof, due to the difference in temperature within and without, which would be extremely objectionable and dangerous in buildings used for this purpose, the following described non-conducting covering was devised. Upon the purlins of the roof is first tightly stretched galvanized iron wire netting of 2-inch octagonal mesh, thus forming a foundation on which to place two layers of asbestos board, the edges of each sheet overlapping about two inches on its neighbor, the two layers breaking joints with each other. On this is laid a covering of tarred paper mopped over with hot asphaltum, and finally a second layer of tarred paper is applied, and also breaking joints with the lower layer upon the hot asphaltum, thus completing what is intended to be a dry and incombustible sheathing; and finally upon the whole is then placed the No. 24 gavanized corrugated iron covering, the same being secured every five inches fore and aft to the purlins below. This roof covering is shown in Fig. 4.

Dynamos.

In the general layout of the dynamos, provision has been made for placing four rows on each side of the centre line of the house. The dynamos are placed diagonally with each other in sections or blocks of four, as shown in Fig. 6. Each machine is supported upon a substantial brick foundation laid up with cement; the several 12-inch walls forming the foundations of each series are bonded together, and, in fact, all built at one time, so that the foundation for one machine acts as a brace for its neighbor. Between these foundations

Read before the National Electric Light Association, Niagara Falls, Aug. 7, 1889.

and the walls of the building is a wooden floor of ordinary mill construction. Directly beneath each machine is left open a section of floor for a thorough ventilation of the armature, through the medium of the cool, although perfectly dry, basement below. All of the dynamos are belted down through the floor to pulleys rigidly secured to the main shaft, the machines being started or stopped at will by an appliance hereinafter described.

The ultimate capacity of this first dynamo-house of the station will be about 80 machines of the ordinary 50 or 60 arc-light size, although much more power may be installed by the introduction of machines of greater capacity than that represented above. The station will be started with about 35 or 40 machines in service, and

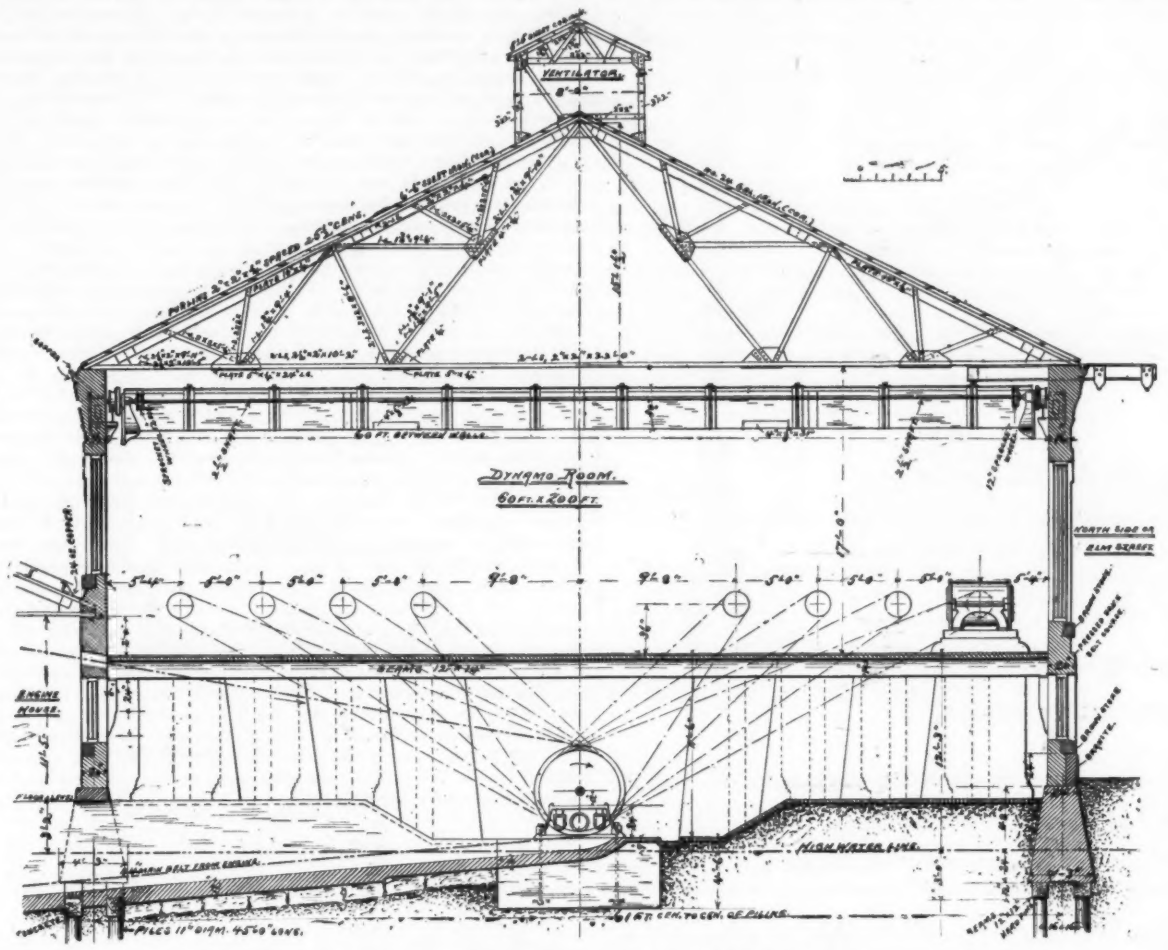


FIG. 3.—CROSS-SECTION OF DYNAMO-HOUSE.

when enlargement becomes necessary, from time to time, the line shaft will be extended as desired, and the available floor space left for that purpose will then be utilized.

The dynamo room is thoroughly lighted on the sides and ends by large windows, all of which, excepting those on the south side or engine-room side, are of three sashes; the combined height being 10 feet and the width 4 feet 8 inches. The windows are placed 10 feet, centre to centre, and the sills 23 inches above the dynamo floor, and being sufficiently low to influence the proper ventilation of the dynamos.

Crane.

Directly underneath each truss of the dynamo-room, and bolted thereto, is built in each side wall a chair or casting for supporting the tracks for the traveling crane, which was deemed essential for moving the dynamo machines from one location to another in an expeditious and economical manner. These tracks are of 9-inch rolled I-beams, weighing 70 pounds per yard, and were cut in 20-feet sections, the bottom flange being bolted to the cast-iron chair and the ends strapped together by a plate, and bolted. The box girder proper was constructed by the Berlin Iron Bridge Company, and is 58 feet in length, end to end, and made up of two plates, 30 inches deep, stayed and stiffened on the side by ¼-inch gusset plates, riveted between two 3 × 3-inch vertical angles on the plate girder. Across the top is placed at a corresponding distance (5 feet 5 inches) two 4 × 3-inch angles 6 feet long, to which also are riveted the gusset plates. At the top, to the vertical plate on the outside, and at the bottom on the inside, are riveted 4 × 3½-inch angle irons, the lower angles forming the track for the trolley, which runs lengthwise with the crane. The sides of the girder are further stiffened and braced by a system of 3 × 2-inch diagonal angles. Each end of the girder rests in a cast-iron chair, and is bolted and riveted thereto. At the extreme end of this supporting chair are located, 72 inches apart, the friction roller wheels, which support the whole; and by means of a shaft operated by a chain from below, and a system of spur gearing acting upon one friction roller wheel at each end of the supporting chair, the whole is propelled lengthwise of the building. A chain is also used to propel the trolley across the building or lengthwise of the box girder. The whole as made from plans designed by us.

Belt Shifter.

The device adopted for shifting the dynamo belt is such that loose pulleys and clutches are entirely dispensed with, the pulleys being rigidly secured to the shaft. The arrangement consists (for each dynamo-driving pulley, the same being 60 inches in diameter) of a curved standard or frame secured to, and extending up from, the floor somewhat above the centre of the shaft. Each side of the frame is provided with a series of narrow guide-rolls, the centres of which are arranged in a half-circle, whose diameter is somewhat less than that of the pulley, the curved frame in cross-section being U-shape; the pulley continuously revolving in the space lying between the two sides. To the rear of the 60-inch pulley, between it and the dynamo, and intermediate of the upper and lower sides of the belt, is mounted a short shaft parallel with the main shaft, having two chain wheels thereon, separated from each other by a distance exceeding the width of the pulley. Two endless chains (made up of flat links) are carried by this shaft, and supported by the guide rolls before referred to. A portion of the chains, or flexible apron, is provided with two-inch wooden rolls, the same extending across and uniting the two chains; the under side of the rolls being some half-inch or more above the periphery of the pulley when the belt is shifted.

In order to shift the belt, the dynamo is first operated by the usual screw or equivalent device to slacken the belt somewhat, to be immediately followed by operating a lever which carries the wooden rolls ahead from the normal position, thereby engaging the inner face of the belt, and, as the chain advances, lifts the belt radially away from the pulley, the belt then being stationary and the pulley revolving. To start the dynamo the operation is reversed; that is the flexible apron is revolved rearwardly, thereby carrying the rolls from the proximity of the pulley, and allowing the belt to re-engage the pulley; the dynamos at the same time being actuated to tighten the belt. This device is indicated in Fig. 7.

Engine House.

The engine room, Fig. 5 as at present completed, is 57 feet wide and about 110 feet long, and covered by an iron truss roof, also made by the Berlin Iron Bridge Company, and of practically the same design, and non-conducting covering, as for the dynamo house. When necessity demands, the house will be lengthened by the removal of the temporary end parti-wall, and the extension of the present iron roof up to the west end of the dynamo house. The change above contemplated will then accommodate sufficient engine capacity for the first dynamo building, and upon the ultimate addition of the second dynamo house upon South street, the engine room will become about 73 feet wide and without any posts. To accommodate this additional width, provision was made in this present roof for splicing out the trusses, and thus the two sides of the roof would then become alike. This can be done without at all affecting the operation of the station, a condition throughout the entire work which we have always carefully considered. Below the floor is located the first leg of the 26-inch exhaust pipe, and above and supported upon the wrought-iron trusses is the 18-inch wrought-iron steam pipe. These two pipe lines will ultimately form a U-shape; that is, passing up one side of the room and returning down the other.

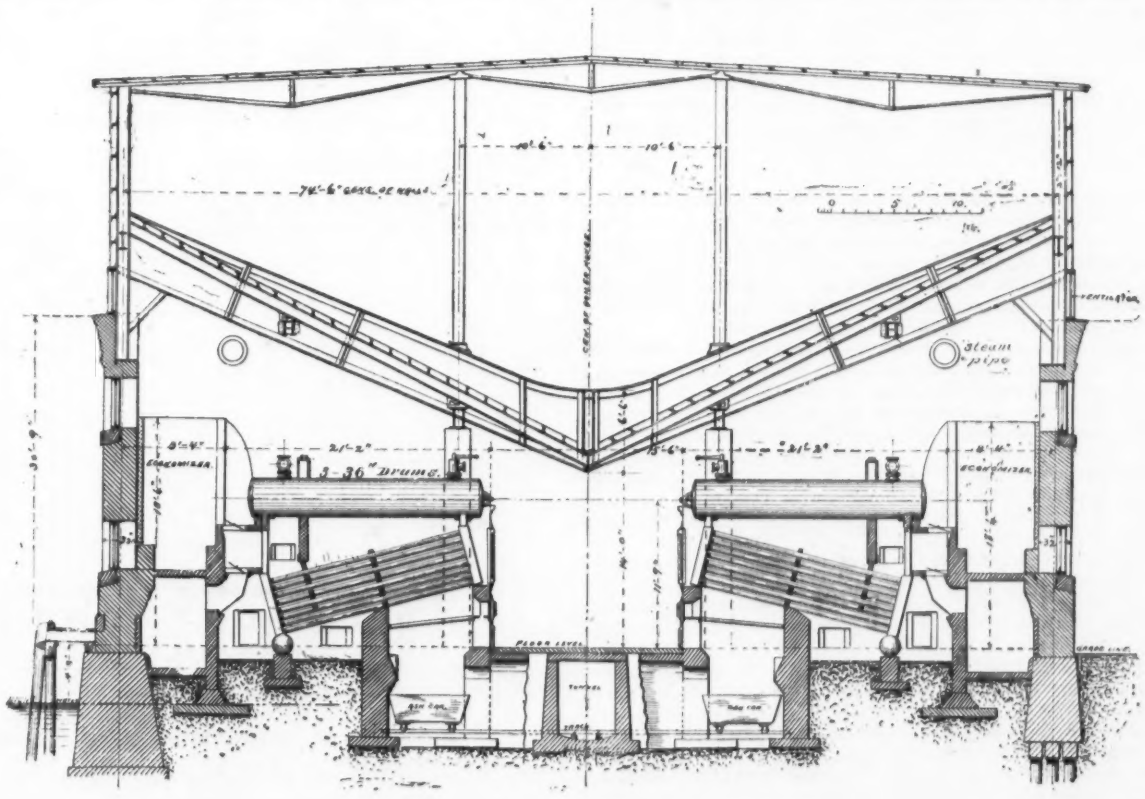


FIG. 4.—CROSS-SECTION OF BOILER HOUSE.

Engine.

The engine, which is of the triple-expansion type, was especially designed for the service of the station by E. Reynolds, General Superintendent of E. P. Allis & Co., of Milwaukee, Wis. The high-pressure cylinder of the engine is 14 inches in diameter, the intermediate cylinder 25 inches in diameter, and the low-pressure cylinder 33 inches in diameter, each 48-inch stroke. The working barrels of each cylinder, together with the heads, are thoroughly jacketed with steam at boiler pressure, also the receiver between the high and intermediate cylinders; and that between the intermediate and low-pressure cylinders is likewise jacketed by steam at boiler pressure.

The valves of all the cylinders are located in the heads, and as the working faces of the valve with this construction are within a very short distance from the face of the heads, the waste clearances are reduced to a minimum. The valve gear is of the liberating type, the valves themselves closing by vacuum-pots located level with the engine-room floor. The automatic cut-off mechanism of the first and intermediate cylinders are actuated by and under the control of the governor, and at the same time the point of cut-off of the intermediate cylinder may be set at a fixed point independent of the governor if it is so desired, while for the large cylinder the point of cut-off is fixed by hand adjustment and always independent of the action of the governor, and thus a perfect means is afforded to adjust the ratio of expansion relatively in each cylinder, and effect the greatest possible economy of steam, and consequently fuel. For the first and intermediate cylinders one eccentric is employed to operate their valve gear, and for the large cylinder one eccentric is used to operate the two steam valves, and one for the two exhaust valves, the object and advantage of this arrangement being to obtain any amount of compression that may be found desirable, independent of the action of the steam valve.

The diameter of the main driving wheel is 17 feet, and of 45-inch face, made in segments and carrying a 44-inch double belt made by Messrs. C. A. Schieren & Co., of New York.

The jackets of the two receivers and of the three steam cylinders are drained by a pump 3 inches in diameter and 5-inch stoke, operated from the condenser of the engine, the water being pumped into the feed-pipe.

The frame of the engine is one peculiar to the builders, and was first designed for heavy rolling-mill practice, and consists of strong wrought-iron bars or rods running from the cylinder head to the pillow block. The rods tie these two parts together, and at the same time form a part of the guide-rod for the horizontal cross-head. From each cross-head extend two hammered iron piston-rods for the intermediate cylinder and large cylinder, and for the small cylinder one rod passes through the back head of the intermediate.

The speed of the engine is one hundred revolutions per minute. To provide efficient lubrication for the main bearings, a positive oil circulation is produced by a pump operated from the valve-gear rocker shaft.

Condenser, etc.

The condensing apparatus for the engines of the station will be arranged in series—*i. e.*, it will consist of several surface condensers and combined air and circulating pumps working upon one large exhaust main, which is common to all engines of the station. This plan was adopted, after some deliberation, for the reason that any particular surface condenser, or a number of such, with its independent motive power for driving the pump of the same, can be operated at will, with the result of producing the desired vacuum upon the exhaust main. And as all of the engines are connected to this exhaust main, and are shut out at pleasure, therefore it follows that any individual engine is not restricted in its operation to the running of any condensing apparatus in the station.

Electric light stations, as we all know, are subject to wide variations in power during a period of twenty-four hours, and to economize power in the operation of the air and circulating pumps of the condensers, we have selected a cut-off engine as the motive power for the condensing apparatus; the point of cut-off of this engine being controlled by the vacuum in the surface condenser. As the load upon the main engines is increased, the natural tendency in the action of the surface condenser results in a decrease in the vacuum by a consequent rise in the temperature of the overflow water, due to the introduction of a larger volume of exhaust steam into the condenser. This decrease in vacuum immediately acts upon the cut-off mechanism of the engine of the condensing apparatus, and, by allowing the steam in the cylinder to follow farther upon the stroke before cutting off, the engine increases in speed, and thus delivers a greater volume of circulating water to the condenser, and at the same time correspondingly increases the volume of discharge from the air pumps. An opposite action results from a diminution of the load on the main engine, and correspondingly slows down the condensing engine.

The first condenser put in is 9 feet long, 6 feet wide, and 8 feet high, and contains 2,496 square feet of cooling surface. These tubes, which are 13-16 inch, and 1¼ inches in diameter, placed one inside of the other, are suspended vertically from brass plates with their upper ends expanded therein. The plates for supporting the smaller tubes are some 8 inches above those for the larger or cooling pipes. These tubes are arranged in 6 sections of 208 pairs to a section, the water of condensation

passing downward through the 13-16-inch tubes, thence upward between the large and smaller tubes, where it then crosses over to the next section, passing downward through the large tube and upward through the smaller tubes, where it again passes forward, the operation being repeated until the water has traversed the six sections, when finally it passes overboard to the river by an 18-inch cast-iron pipe, whose end is submerged about four feet below low water, and consequently acting as one leg of a siphon. The injection pipe is laid in South street, 200 feet south of the overflow, and commences at a well having three screen chambers leading therefrom to the river. The screens are covered with copper wire, ¼ inch and 3-16 inch mesh.

The condensing apparatus engine is 12 inches diameter and 16 inches stroke, with liberating valve-gear and of the same pattern as the large engine. The air and salt water circulating pumps are respectively 24 inches and 16 inches diameter, each of 16 inches stroke. Intermediate of the air and circulating pumps is located on the overhead crank shaft a plain fly-wheel 10 feet in diameter, the centre of the shaft being 10 feet 1 inch above the floor.

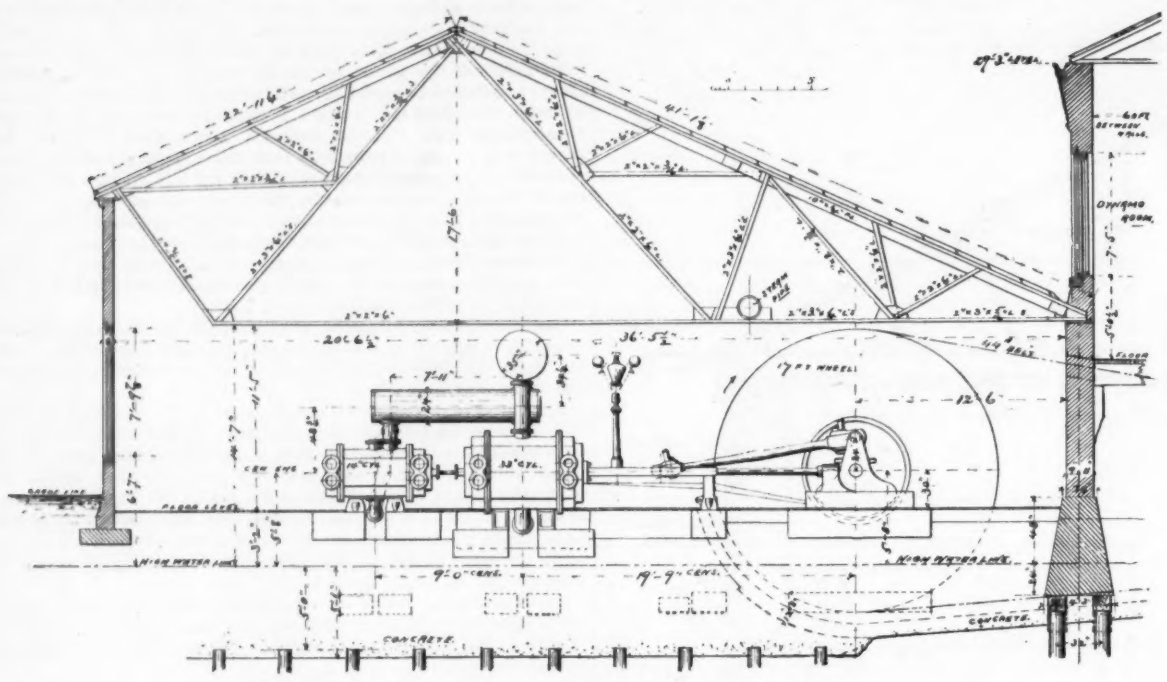


FIG. 5.—SECTION THROUGH ENGINE HOUSE.

Automatic Boiler-Feeding Mechanism.

Upon the opposite end of the shaft of the condensing apparatus engine is located the feed pump. The pump has an automatic device for controlling its stroke by the height of the water in the boiler, and thus the stroke of the feed pump is automatically lengthened or shortened, as the case may be, to correspond with the actual quantity of water evaporated in the several boilers. With this device we are enabled to run the pump at its full capacity, even though its stroke may be from 0 up to 16 inches, without the use of a "by-pass" and thus at times save considerable power. This device consists of a float mounted in the boiler and operating a balance-valve in the feed-pipe line, which, by an increase in pressure in the feed-pipe due to an excessive height of water in the boiler, causes the closing of the balance valve. A reaction then takes place upon a differential water cylinder, and the movement due to this increase in pressure upon the piston contained therein shortens the stroke of the feed pump. A decrease in water level in the boilers has the effect of opening the balance valve of the feed pump wider, which momentarily has the effect to reduce the pressure therein, and this reaction upon the differential piston acts to lengthen the stroke of the feed pump, and consequently discharges more water, as required by the increased evaporation.

Steam Pipe.

In a station of the proposed capacity of ours it becomes absolutely essential that the main line of steam pipe should be so constructed that full boiler pressure can be maintained upon it during every moment of the year; and to avoid any possibilities of leakage that would prevent its use at any time, we have so arranged all joints in the main line that if any leakage should occur it may readily be remedied without removing the steam pressure therefrom.

The main line of pipe is 18 inches inside diameter, and was made from our designs by the Continental Iron Works, of Brooklyn, N. Y., and is of ½-inch steel plate, with the horizontal seams welded, while at the ends for connecting the various lengths together a bell flange was turned out from the material of the pipe itself. These flanges were then double riveted together and the joint calked up against its neighboring flange from the outside. Where a wrought-iron pipe joins a cast outlet or inlet tee, or to an elbow, they were likewise riveted to the cast-iron flange, as shown, and the joint made tight by calking the bevel edge of the wrought iron flange against the cast-iron. This also admits of recalking, should it become necessary at any time to do so, without removing the pressure from the pipe. The flange joints of all of the cast-iron pipe in the main line are made with male and female joints, and into the recess of which is placed a gasket of vulcanized asbestos. The flanges are then bolted together with ⅞ inch bolts spaced about 4 4-10 inches centre to centre.

At each outlet and inlet, and directly upon the main line, is placed an open way Chapman valve, having brass seats. The flanges of these valves are likewise provided with a male and female joint, so as to prevent any possibility of the joint blowing out. The piping upon the main line, beyond these valves, is of ordinary lap-welded tubes having screwed ends, fitting standard flanges and cast-iron elbows. Should any section of this primary pipe leak at any time it can be repaired by shutting it out by means of the valves above referred to, located in the main line.

The 18-inch main steam line will run along each side of the engine room house, and at its extreme ends the two lines will join, and thus form a U for feeding all engines proposed for the station. Steam in the meantime is taken from the boilers into each end of the pipe. Ample provisions are made for removing all water of condensation from the pipe, by collecting it into cast-iron wells having water glasses thereon, and then trapped into the feed-water ank, from whence it is pumped back into the boilers.

Shafting.

The engines are belted to jack pulleys secured upon open hearth cast-steel hollow shafts, through which freely passes and revolves the 6-inch hammered iron line shaft. On one end of the hollow shaft is cast a head 24 inches in diameter, and to which is bolted a 54-inch Hill friction clutch, to transmit the power of the first engine of 500 h. p. As the hollow steel shaft is supported in bearings 9 inches in diameter, and independent of the line shaft, it follows that the engine and its jack pulley, and of course the hollow shaft, can be stopped at pleasure by throwing out the friction clutch, and still allow the main line to revolve as usual, but without touching the inside surface of the hollow shaft. In case the main line is in operation, and it is required to start up any engine, it is merely necessary to put the engine in operation and throw in the friction clutch, and consequently connect the whole firmly together. Alongside of the clutch upon the end of the hollow shaft is still another, 60 inches in diameter and of 800 h. p. capacity. This clutch is arranged so that the main line may be cut out at pleasure at that point.

All of the bearings in which the shafting revolves are of liberal length, and provided with bronze ring oilers, some having three rings, while others have but two. These rings encircle the shaft and revolve by contact therewith, thereby carrying a large quantity of oil from a chamber, formed in the lower part of the pillow blocks, to the upper surface of the shafts, and thus provide ample lubrication, a feature very essential in view of the fact that the shafting is to run 300 revolutions per minute, and that the bearings, especially those of the hollow shafts, are of large diameter.

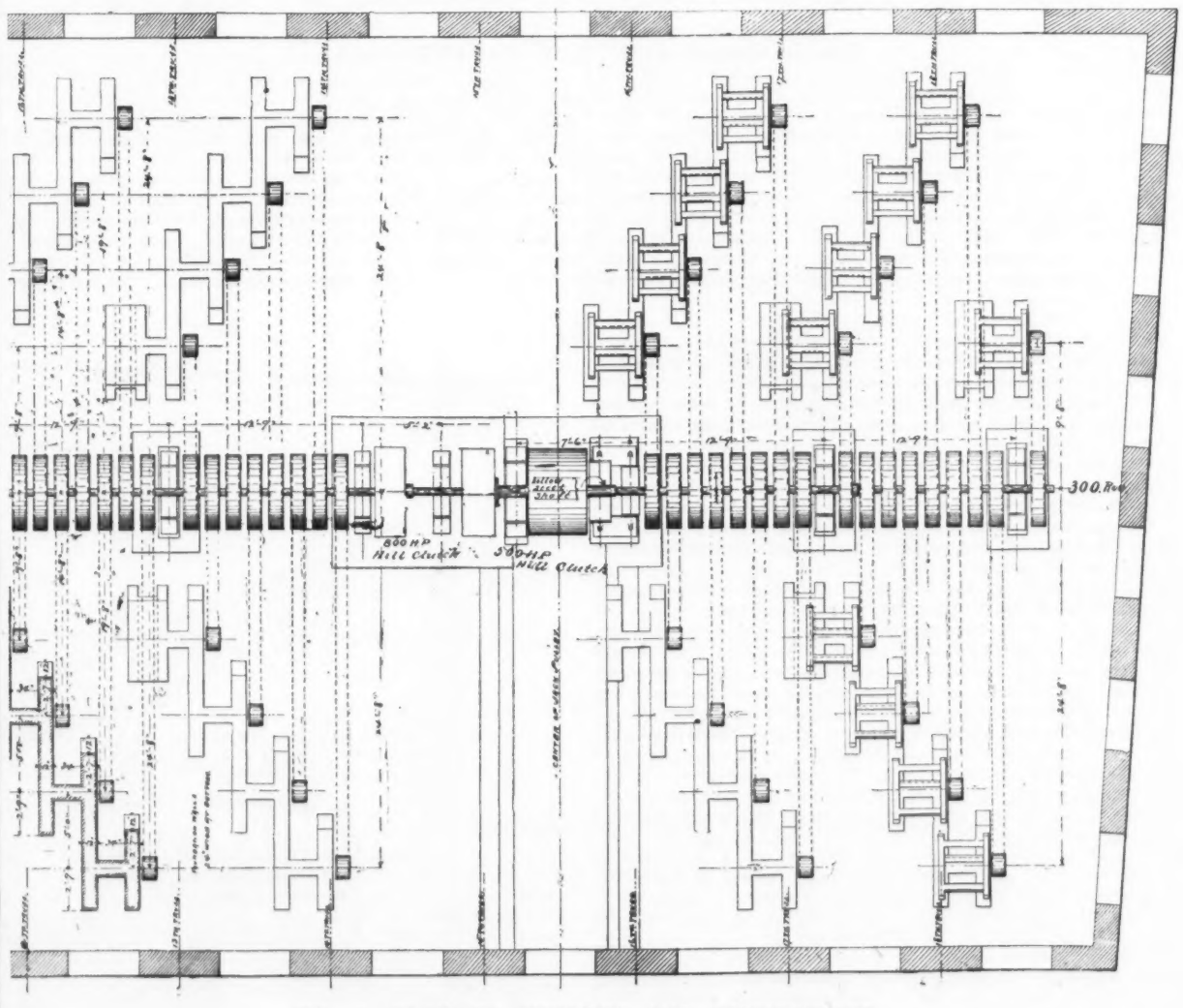


FIG. 6.—PLAN OF DYNAMOS AND FOUNDATIONS.

Sea Wall.

The most difficult portion of the foundations which were put in was experienced when we commenced that of the boiler-house wall upon the river front. This resulted from the fact that man had from time immemorial driven piles indiscriminately to replace those which had become worn out or broken under the several old wharves which had been in existence at this site. When the former wharf, as we found it at the acquisition of the property, was removed, preliminary excavations were made, and an attempt made to remove the old piles found thereunder. During this operation the fact was revaled that the piles were of a miscellaneous diameter and of different length, none of them being sufficient for our purposes of building upon, some pulling out quite easily, while their neighbors would be broken in the attempt. This fact prompted us to drive all of the old piles thus left standing below the grade of the new ones which we wished to insert, and thus get the old piles beyond a point so that they would not interfere with our platform which we proposed to place upon the head of the new piles. The piling upon this wall consisted of four rows, spaced 30 inches centre to centre and parallel with the harbor line established by the city, the centre of the cluster of piling being 6 feet 6 inches from the established harbor line.

In addition to these four lines of piling, there was driven at every alternate row inland and at right angles to the harbor line a series of four piles spaced 4 feet 6 inches, 13 feet 6 inches, and 17 feet 3 inches, respectively, from the inner row of piles. These piles, which were of spruce, and of 11 inches diameter at the butt and 54 to 50 feet long, were driven down with a ram of 2,200 pounds, and followed up at the last by a follower until hard bottom was reached, which varied from 45 to 53 feet below high water. They were then cut off uniformly 7 feet 6 inches below established high water mark by a circular saw hung up in the ways of the driver, and which was operated by the engine used for driving upon the floating scow, the number of new piles being 547. When this was accomplished, after the usual amount of damage to the several saws incident to the very frequent contacts with the stone ballast found below, the heads of the piles were then surmounted by 10 x 10 spruce timbers and securely fastened to the head of each new pile driven by ¾-inch drift bolts. These timbers were alternately of 22 feet and 8 feet 6 inches in length. And finally, upon these pile caps, were securely pinned and closely laid 6-inch spruce planks, which thus formed a platform 26 feet wide and extending the whole length of the river wall.

Inasmuch as there were already in place a large amount of old piles, 288 in number, which had been redriven below the line of the new, Portland cement concrete, thoroughly mixed in the proportion of one cement, two sand and one broken stone and gravel, was placed in bags and thoroughly rammed down between the new and upon the head of the old piles, and so left that when the 6-inch spruce planking was placed upon the stringers of the new piles, a bearing also would be had upon the old as well as upon the new. Upon this timber platform, which runs inland from the river 26 feet, as above stated, was built the wall proper for the boiler-house and its surmounting coal pocket. The centre of this wall, as we have before stated, is 6 feet 6 inches from the harbor line and the stone foundations, having a base of 8 feet, were started upon this platform and well bedded in cement; all bottom stones being laid as headers, and of 8 feet length. Above this the wall gradually tapered to 4 feet 9 inches in thickness at the 4-foot 8-inch level, this wall being laid up, as other foundation walls for the station, with cement mortar of one part of cement to two parts sand. The face of the wall being thoroughly pointed up 2½ inches deep with Portland cement.

This same construction of wall and four rows of piling was carried around the northeast corner of the house, to prevent any liability of washing from the river. From this point for the remaining portions of the walls the piles were driven in three rows, 16 inches centre to centre of caps, and spaced 42 inches lengthwise with the wall. These were cut off 84 inches below high water, and surmounted by a 12 × 12 hard pine stringer, as for the dynamo-house. The north and the whole of the east wall has a base 4 feet 6 inches wide, tapering up to 3 feet 6 inches wide at the 4-foot level. These walls were laid up in cement, as for other underground sections.

Boiler House.

The first section of the boiler house built is 68 feet long and 71 feet 10 inches wide, as shown in Fig. 4, to accommodate four sections of boilers, and is so arranged that it may be lengthened the full width of the lot as required, as ultimately it will be 200 feet long. There are two rows of columns running lengthwise with the building spaced 14 feet 3 inches centre to centre, while across the house the centre lines of the two rows are 21 feet. Under each column are driven a cluster of 15 piles to a depth of 45 feet to 53 feet below high water, and upon these

are built the cut granite piers for supporting the coal pocket. The piling for side walls and piers was carried about 15 feet beyond the actual line of the boiler-house, so that when the parti-wall is removed for extension, the driving of additional piling will not disturb any of the permanent structures. The walls of the house are 26 feet 1 inch above the floor, the first 5 feet 10 inches being 36 inches thick, with granite underpinning, and the balance of 32-inch wall. Lengthwise with the house is an ash tunnel 4 feet 6 inches wide and 6 feet 4 inches in the clear, in which is a tramway, and by means of a turn-table opposite each transverse tunnel leading directly underneath each boiler grate; the carts for collecting the ash s traverse back and forth as they become filled.

Directly over the boilers will be stored the fuel for the station in a wrought-iron coal pocket 25 feet in depth,and of a capacity for this first section of 2,500 tons. Being directly upon tide water, the coal is taken from the vessel alongside of the building, and is landed at once to any section of the pocket. The coal, after being weighed in a movable machine, is deposited opposite to the furnace doors by gravity, the floor of the pocket being built on an incline to facilitate the discharge of the coal.

Boilers.

The first section of 500 h. p. boilers for the station were made by the National Water-Tube Boiler Company, of New Brunswick, N. J., and are, as the makers' name implies, of the water-tube type. They are set in two batteries to a section, each of which is of 250 h. p., upon the commercial basis of 30 pounds of water evaporating into dry steam per hour; and, as the engine is guaranteed to develop an indicated horse-power for 12.6 pounds of water per hour, the boilers will therefore evaporate water enough to develop by the engine about 1,100 h. p. per section.

Each boiler of the section is made up of 144 steel tubes 4 inches in diameter and 16 feet long, the tubes terminating into charcoal iron cast headers lying horizontally. These several layers of headers are nippled together with 4½-inch steel tubes, and are finally connected to the saddles by 5-inch nipples. Upon the top of each boiler of the section are placed three 36-inch steam and water drums, made up of 7-16 inch steel plate, to the lower side of which, at its extreme ends, are riveted the up and down-take saddles which receive the end of the 5-inch rear down take tubes, and at the forward end the 5-inch nipples before described, which are expanded into the upper row of horizontal headers. Inside and outside hand holes are provided opposite the ends of each tube, the former for preventing serious accident to those in charge of the boilers in case of the breakage of a hand hole plate bolt, and the latter for providing the necessary water-tight joint.

The length of the grates under each boiler is 6 feet, and the width of the furnace 9 feet, and they were designed for the ultimate introduction of a mechanical stoker of some improved pattern when the next series of boilers are placed in position. Underneath each section of grates, and below the level of the boiler house floor, is a pit or tunnel, as before stated, in which is a tramway for conveying the ash and clinkers collected in a car provided for that purpose, and by means of a turn-table the car is transferred to the longitudinal pit or tunnel located at the centre of the boiler house, from whence it is propelled to the street, and finally hoisted by power into the cart for conveying it away. This system of tunnels is plainly shown in Fig. 4.

Economizer.

At the rear of the boilers, and common to each section of two boilers, is placed vertically a Green economizer, having 192 4-inch cast-iron tubes, each 10 feet long. The flues leading to the economizers are so arranged, as will be seen by referring to Fig. 4, that the gases may be diverted by dampers through the economizer, or into the underneath direct flue leading to the chimney, at will.

Chimney.

The chimney, which is 14 feet interior diameter, and when completed will be 238 feet in height above zero level, is located midway between the two streets, and about 125 feet from the river line, and is surrounded by the engine room. The foundation is composed of 405 spruce piles, which are driven down from 45 to 53 feet below established high water line, and cut off 5 feet below this line, and upon these, encased in sheet piling, is a bed of concrete 44 feet wide by 59 feet long and 6 feet 9 inches deep, thus forming a block of 16,000 cubic feet, and weighing about 2,000,000 pounds, which is composed of one part Norton's hydraulic cement, two parts sand and three parts broken stone. Upon this bed was started the brick work, 36 feet square.

The first five feet of the walls are laid up in the proportion of one cement and one sand; above that and up to the 85-foot level the proportion being one to two, and the balance of the walls laid up with lime mortar composed of four parts sand, two lime and one cement. All surfaces of the core or flue that are exposed to the heat are laid up with lime mortar. For the outside walls, as for the other buildings, red soapstone finish mortar was used, which becomes very hard after a short exposure or when dry. The brick used was a quality especially burned for us by a local company, our only requirement being that all of them should be extremely hard and tough, without regard to color and size, as from the large quantity of brick required for the work, ample good colors for the outside work are readily culled.

The chimney at the base is made up of three walls, the outer being 28 inches thick, the intermediate 12 inches, and the core or flue 16 inches. The intermediate wall is octagon in cross sectional and surrounding the core or flue, which has an internal diameter of 14 feet. The outer and intermediate walls are joined together by eight buttresses, both being carried up at the same time, and thus thoroughly bonded together. Eight inside buttresses also extend to within 1 inch of the outside of the flue wall, and are carried up to its extreme height. As the intermediate walls are carried up plumb and the 28-inch outside wall has a batter of 2.8 inches in 10 feet, they finally intersect at the 90-foot level, and from that point the walls are gradually reduced to 20 inches in thickness, thence to 16 inches, and finally 12 inches at the commencement of the enlargement for the cap.

At the 3 8-foot 2-inch level a series of granite stones are placed in each corner of the square; the same are so cut that the form of the chimney is changed to an octagonal cross-section at the 46-foot 2-inch level, and that form is thereafter maintained. From this 46-foot 2-inch level, at each corner of the octagonal, are pilasters 24 inches wide and projecting 4 inches from the surface of the wall. The flue or core of the chimney has a 16-inch wall, as above referred to, and is reduced at the 78-foot 2-inch level to 12 inches, and again at the 163-foot 2-inch level to 8 inches, and is thus continued up to within 4 feet of the top. At the bottom of the chimney means are provided, by arched openings through the various walls, for access to all spaces in the base for cleaning, etc. These passage ways in the intermediate wall, by ascending vertical ladders built into the outer and intermediate walls for that purpose, also afford access to the damper bearings which are on the 37-foot 2-inch level.

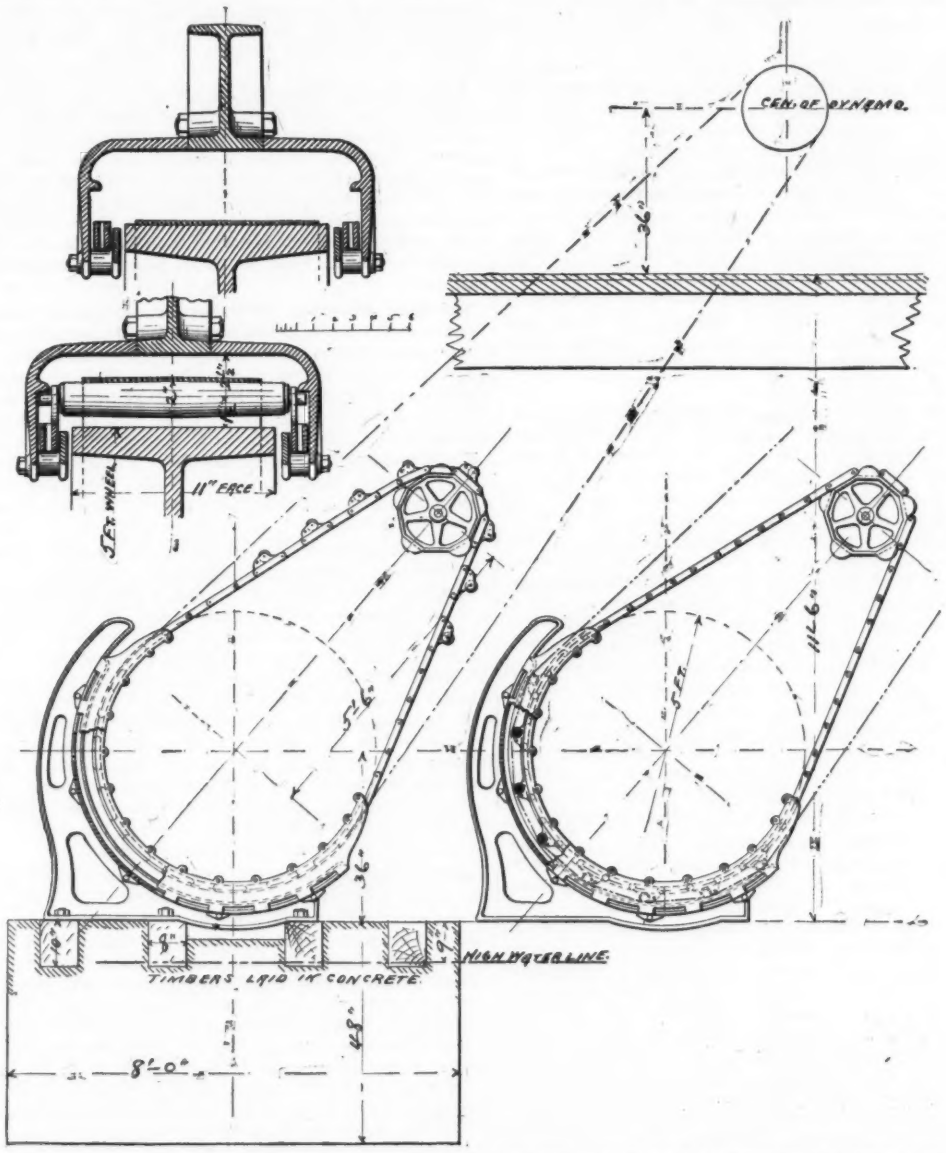
The damper is made up of two sections, each hung at an angle of 30 degrees from a horizontal line, so that by rotating each 60 degrees the two extremes of their motion will be reached. Each half leaf of the damper is composed of six sections of ¾-inch cast-iron plates, having flanges thereon for bolting together, and through which passes a 2 × 2-inch wrought-iron spindle or shaft, the ends of which are turned down to 1¾ inches in diameter, which rotate on anti-friction pulleys 3⅜ inches in diameter. The levers for operating the dampers are located between the outer and intermediate walls, and the connections therefrom pass downward, thence through the wall and finally outside of the chimney, where they are acted upon by the damper regulator. This unusual course was provided so that all of the connections would be protected from the weather, as the dampers themselves are above the roof of the engine house.

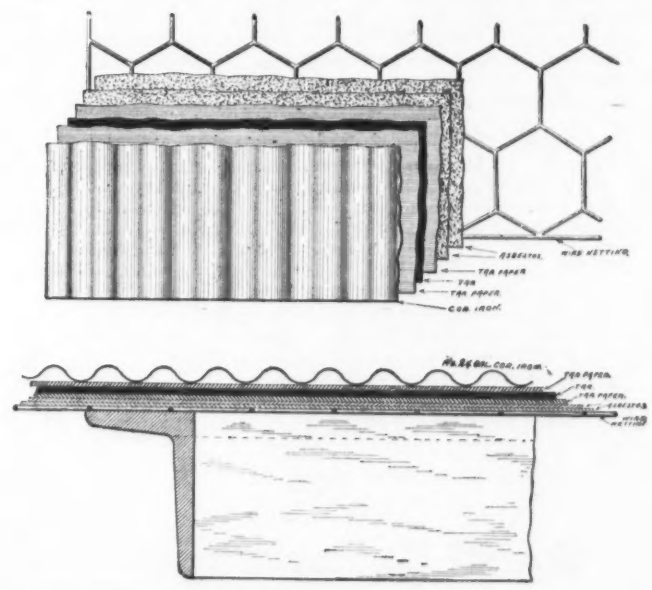
The cap surmounting the chimney is of an octagonal form for the cone as well as the outside, and is made up of sixteen sections bolted together with copper bolts; in the recess formed between each joint is calked two layers of one-eighth inch copper wire for the purpose of forming a water-tight joint, and thus protect the underlying brick work, and at the same time forming a metallic contact between the several sections of the cap, and also serving as a guard against lightning. To the cap proper is secured by copper bolts a cast-iron cresting of plain design and of about 5 feet in height, and which also forms part of the lightning conductor. The absolute metallic contact between all sections of the cap and cresting prompted the connection therewith of the 1½ × ⅜-inch copper rod, which terminates at its lower end, to a 16-inch cast-iron water pipe running to the river, and consequently always submerged, leads us to believe that all possible provisions have been made for this erratic, uncontrollable, alternating current.

Between the intermediate wall and the flue is built in, a ladder formed of 1¼ inch round iron, one end of which is built solid into the intermediate wall, while the other end is left free to accommodate itself to the expansion of the flue. This ladder is located a short distance from the angle of the octagon, and is carried plumb the whole length of the flue. Directly above and below the opening for the smoke flue, which is 10 feet wide and 18 feet high, are built into the outside wall and 8 inches from the outside thereof, two 1¼ rods, the ends of which are 1½ inches in diameter and secured to a heavy cast-iron plate. Above these are built, in every 20 feet, 4 × ½-inch and 3 × ½-inch bar-iron laid edgewise which, when bolted together, forms an octagon of sufficient size to extend to within 8 inches of each side of the chimney. The last of these bar-iron braces are placed at the 153-foot 2-inch level. The method of construction is of a very simple nature. At the commencement a 12 × 12-inch cast-iron plate, having theron a centre or bench mark, was placed in the centre of the chimney, and from that centre mark, the axis of the chimney is re-established every 20 feet throughout its height.

All material used in construction was conveyed to the top by an elevator having a platform 4 × 4 feet, arranged to run up and down inside of the shaft, and guided at opposite corners by 6 × 6-inch hard pine vertical timbers, which also serve for the gripping device to act upon in case of accident to the manilla cable. As the work progresses the upper frame work, carrying the overhead 30-inch shieve, is hoisted up and new frame work added directly below. At the same time interior scaffolds were built in every 5 feet and secured by 6 × 8-inch timbers placed in the wall. There will be used in its construction 1,500,000 bricks.

In conclusion, we desire to place on record the fact that the development and phenomenal success of this company, which started but five years ago with 29 lights, and the inception of this new station, marking an advance in this field of engineering, is due to the broad and comprehensive labors and achievements of Marsden J. Perry, Esq., vice-president and general manager, a gentleman of sound business abilities, readily grasping engineering details, and fully appreciating the axiom that the "best is the cheapest" in the end.





FIGS. 7 AND 8.—BELT SHIFTER, NARRAGANSETT COMPANY'S STATION, AND DETAIL OF ROOF.

The Clambake of the Year.

The eleventh annual clambake given by the American Electrical Works, of Providence, R. I., to the electrical fraternity took place on Saturday, Aug. 10, at the Vue de l'Eau Club, on the Providence River, and, as usual, proved a most enjoyable affair. The attendance was large and the day perfect.

Lunch was served at eleven o'clock, after which the usual games of foot-ball, base-ball, etc., were enthusiastically indulged in. The ball game between Boston and New York was rather exciting, and, owing to the superior decisions of Umpire Noonan, resulted in a victory for New York. Shortly before dinner the usual group photograph was taken. At three o'clock the bake was ready to be opened, and when the guests were seated a cordial welcome was extended by Mr. Eugene Phillips, whose genial countenance, like that of Mr. W. H. Sawyer, betokened the inward pleasure this gathering afforded him. Col. C. M. Ransom acted as master of ceremonies, and a welcome to the city of Providence was extended by Assistant Postmaster-General Williams. The attack on the dinner then began. At each plate was a mysterious-looking parcel, which was found to contain something that would delight the small boy's heart, and that it succeeded in arousing the enthusiasm of the large boy was evidenced in the unearthly sound that broke forth from scores of tin fish-horns, for such were the contents of the parcel. Attached to each horn was the menu card, on which was enumerated the delicious dishes that go to make up a genuine Rhode Island clam dinner. During the feast letters expressing regrets at not being able to attend were read from Brainard Rorison, J. F. Elliott, H. W. Pope, J. R. Magee, P. H. Alexander, Geo. A. Hamilton, F. G. Waterhouse, E. T. Gilliland, B. E. Sunny, P. M. Church, H. D. Fuller and H. M. Whitney. No fewer than 120 expressions of regret were received.

The literary part of the dinner was opened by Mr. Frank Ridlon, whose remarks on the "Past, Present and Future of Electricity" were boisterously received. Mr. H. E. Duncan, in speaking of "Good Time," referred to the convenience of non-magnetic watches. Mr. H. B. Cram elucidated the subject of "Wire" in a masterly manner. Messrs. R. F. Ross and C. E. Stump endeavored to support the

"Electrical Press," while Gen. C. H. Barney orated on "Electricity and Musical Instruments," taking for his text the violin. An unusual pressure on our space this week prevents the publication of his address; but it has been privately printed, and he will no doubt be pleased to furnish copies upon application. Prof. W. A. Anthony dwelt on "Electrical Execution," and Mr. G. G. A. Peterson accused Mr. Phillips of contributing to the success of "Long Distance Telephony" by supplying wire of good conductivity. Mr. Phillips modestly abstained from denying the charge. General E. S. Greeley spoke of the great progress in the business of "Electrical Supplies" during the last twenty-five years, and avowed his intention of being present at every similar clambake. Col. H. C. Davis discussed the possibilities of the coming "World's Fair" in New York, and thought it would surpass anything of the kind attempted in the history of the world. Three cheers and a tiger were then given for the hosts of the occasion, and the clambake of the year was over. Among those present were:

ATTLEBORO, Mass.—H. M. Daggett, Jr.

BOSTON—G. W. Adams, D. A. Andrews, W. S. Barnes, C. E. Bibber, F. H. Baldwin, C. B. Burleigh, Chas. Burgher, F. J. Boynton, J. H. Clarke, R. B. Carr, Levi Cofren, D. W. Dunn, H. E. Duncan, Frank Fuller, E. W, Godfrey, J. D. Hall, Albert Howard, W. E. Hooton, C. W. Holtzer. D. A. Harrington, D. Killicutt, W. S. Key, Chas. E. Lincoln, I. W. Larish, N. W. Lillia, W. C. Merrill, Jr., G. W. Millard, Preston C. Nason, W. B. Pettengell, H. J. Pettengill, C. A. Perkins, R. F. Ross, Frank Ridlon, C. M. Ransom, A. L. Russell, W. E. Stow, A. C. Shaw, Fred Smith, M. W. Turner, Edmund S. Willard, W. C. Woodward, H. B. Cram.

BROOKLYN, N. Y.—E. F. Peck, W. G. Sellers.

CHICAGO—Dr. A. de Bausset, W. G. Halm.

CAMBRIDGE, Mass.—F. H. Raymond.

ELIZABETH, N. J.—R. Stewart.

FALL RIVER, Mass.—Chas. Sylvester.

FRANKLIN, Mass.—A. H. Munn.

GRAND RAPIDS, Mich.—S. G. Hallen.

HARTFORD, Conn.—G. L. Best, J. J. Gates, C. G. Perkins.

HOPEDALE, Mass.—A. F. Gifford.

LOWELL, Mass.—J. Y. Bradbury.

LANGHORNE, Pa.—J. H. Marshall, A. M. Wildman, John Wildman.

MANCHESTER, Conn.—W. A. Anthony.

MILFORD, Mass.—G. M. Greene.

MILLBURY, Mass.—P. H. Wood.

NEWARK, N. J.—C. O. Baker, Jr., Edward Colby.

NEW BEDFORD, Conn.—R. S. Tabers, W. R. Sherman, W. K. Wagner.

NEW HAVEN, Conn.—E. B. Baker, G. A. Smith, E. N. Clarke.

NORWICH, Conn.—G. W. Phillips, C. L. F. Wert.

NEWPORT, R. I.—J. Carroll.

NEW YORK.—P. C. Ackerman, C. H. Barney, Henry C. Davis, Chas. H. Davis, E. S. Greeley, N. .C Galvin, F. H. Hammond, B. F. Hamilton, James Kempston, Norman McCarthy, W. Peters, C. E. Stump, A. F. Stanley, Geo. Worthington, H. M. Williams.

PATERSON, N. J.—R. H. Cunningham, J. F. Norman.

PAWTUCKET, R. I.—W. E. Esten, N. B. Denison, G. C. Gammon.

PHILADELPHIA, Pa.—J. H. Sturtevant, J. A. Cary, H. A. Cleverly.

PROVIDENCE, R. I.—H. A. Breckenridge, H. W. Breckenridge, H. C. Bradford, L. W. Clarke, E. M. Carhart, H. A. Crowley, J. O. Darling, G. H. Darling, J. I. Drake, W. W. Dempster, W. P. Gannett, J. F. Hedge, Jr., P. J. Hurlburt, W. J. Hathaway, C. T. Howard, F. C. Holtz, Alex. McLelland, W. D. Mason, W. W. Munro, G. G. A. Peterson, G. C. Perkins, S. R. Payson, C. R. Remington, G. T. Swartz, W. H. Sawyer, H. H. Sherman, G. A. Steere, Gardiner C. Sims, V. A. Thomas, E. W. Tyler, W. J. Thurston, G. H. Thurston, C. H. Williams, A. C. White, H. H. Wells.

TAUNTON, Mass.—Abner Coleman.

SMITHFIELD, Mass.—G. W. Wells.

WARWICK, R. I.—C. W. Baker.

WORCESTER, Mass.—Wm. Brophy, H. H. Fairbanks, W. H. Vaille.

WASHINGTON, D. C.—G. C. Maynard.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, August 10, 1889.

The New American Electrical Arc Light Company have sent machines and lamps to Spokane Falls, where the big fire occurred recently. The plant is badly wanted, and will be put into service immediately. It is rather interesting to note that they supplied a plant recently to Seattle under somewhat similar circumstances.

Mr. L. W. Splane, who is superintendent of all the electrical construction work of the Standard Oil Company, and hails from Oil City, Pa., was a caller at Jesse Bunnell's last week. He is an interesting and entertaining companion, and gives one many new ideas on electrical work. I had also the pleasure of meeting at Bunnell's, which is really an electrical exchange in itself, Mr. R. Stewart, superintendent of telegraphs of the Jersey Central Railroad.

Habirshaw Wire is being used, I learn, for the big new Edison plant at Elgin, Ill., about which you published details recently. It is also being used at the Tremont Theatre, in Boston, in all the various sizes. The company are just completing a 9 conductor cable of special construction for service under water. I would recommend your readers, by the way, to secure copies of the tables printed on linen by the India Rubber and Gutta Percha Insulating Company, of dimensions, resistances, weights, etc., of pure copper wires. These tables are very valuable, and should be in everybody's possession.

The Hussey Battery Company has lately been incorporated in New Jersey for the purpose of manufacturing and selling the atest patented improvements in bluestone battery. Employing the patents No. 303,644 and 291,143, they get a very low internal resistance and a heavy ampèreage, and the current is used for running motors for electric lighting. It is also proposed to use them for charging storage batteries, and it is claimed that they are cheaper than dynamos for supplying telegraph current. Mr. J. M. Peters is the superintendent of the company; Mr. J. R. Bowen, secretary, and Mr. C. A. Hussey, treasurer.

The C. & C. Motor Company have shipped one 10 h. p. motor and one 15 h. p. motor to Cincinnati, and one 5 h. p to Washington, to run printing presses. They have also sent a 15 and a 5 h. p. to Chicago for printing offices, and a 10 h. p. to Harrisburg. One order received from the latter place on the 8th of August was for three 20 h. p. and one 15 h. p. This enormous and continued demand on the company for large sizes of motors really perplexes the company, as they expected the small motor business to fully occupy their energies. In point of fact it does so, but the rush of orders for the larger sizes in the last few months has given an altogether new face to their business, and they have rapidly prepared themselves for the new emergency. The consequence is that large C. & C. motors are now being built and sent to all parts of the country as fast as they can be made.

The National Water-Tube Company, of New Brunswick, N. J., are the manufacturers of the Moore system of water-tube boilers. The tubes used in this boiler are of the very best quality of lap-welded wrought iron of small diameter, and the boiler is made up of a number of these connected together by a system of headers into which the tubes are expanded, and by this means safely secured. The space occupied by these boilers is said to be only two-thirds that required by the tubular boilers, and one-third required by plain cylinder, two-flue boilers of the same power. The manner in which the triangular sections or headers are put together is very ingenious, as the height and width of the boiler can thus be made to suit any requirement as to space, and it is easy to clean and examine the boiler thus made. Another point that electric light men will appreciate is, that they make steam quickly and of the best quality and that sediment and scale are avoided. The company have offices at 18 Cortlandt street, and 46 North Seventh street, Philadelphia.

The Tucker Electrical Construction Company.—The business of the Tucker Electrical Construction Company, who were until recently agents for the Mather Electric Company, has increased so largely in the construction of electric light plants for other companies, and in interior wiring, etc., that they have decided to devote the entire energies of their well-equipped office, excelled by none in the country, to this branch of work. The success of this company, while remarkable, has been deserved, and is undoubtedly the result of a well-defined policy. At the outset of their career it was determined to adhere to the construction only of work of the best character, and the result has therefore been as might be expected. The company are doing all the wiring for the Manhattan Electric Light Company and Curtis & Dean, the energetic New York agents of the Thomson-Houston Company. They are now employing nearly 75 men on outside wiring. The Tucker Company are, as usual, ahead at the American Institute Fair, which they will illuminate with over 500 incandescent lights. The work of installing the big plant at the Progress Club has also been begun by this company.

The Wenstrom Northern Electric Company was organized June 19, 1889, for the purpose of introducing the Wenstrom electric lighting system into this country. As the readers of your pages will note, they have a most efficient machine, which is already recognized as the standard type in Europe. It is simple in construction, being one of the first, if not the first, iron-clad type, undergoes little wear and tear, and yields a very high output. An additional feature in the armature is that the wire is buried so as to lessen the space or clearance between the armature and the fields. The officers of the company are Dr. J. B De Lery, President; B. Blum, General Manager, and B. J. Sturges, Secretary and Treasurer. The main object of the new corporation is to introduce their system for light and power in the Eastern, Middle and Western States. A neat pamphlet has been prepared and issued on the subject of the merits of the Wenstrom system, and it can be had on application. The Wenstrom people have already installed during the past year 1,000 lights at the St. James' Hotel, Baltimore; 1,000 lights at the Albion Hotel; 1,000 at the Hotel Rennert, and 1,000 at Jacob Shaffer's new pork packery. They have also installed 1,000 at Indianapolis through the Indianapolis Electric Light Company.

McIntosh, Seymour & Co., of Auburn, N. Y., are busier than ever, and are still running night and day, as they have done now for seven months, endeavoring to fill orders for their engines, which are so rapidly coming into favor. They have on hand now orders for one 400 h. p. double tandem compound engine for the Salem Electric Light Company, Salem, Mass., being the second one for that place, and five 300 h. p. self-contained tandem compound engines for the West End Railway Company, of Boston, Mass. These engines are very heavy, the wheels for each one weighing 12,000 pounds, and each engine weighing 32,000 pounds. Also two self-contained tandem compounds for the Cambridge Electric Light Company, of Cambridge, Mass., making six for that company; one 200 h. p. tandem self-contained compound for the Lynn Gas and Electric Company, to supply power for the electric railway in Lynn, Mass.; two 125 h. p. self-contained tandem compounds for the Chelsea Gas Light Company, of Chelsea, Mass.; one 125 h. p. self-contained compound, for H. D. Warner, of Greenfield, Mass,, which will go into an electric light plant being built there; one 65 h. p. self contained tandem compound, for an electric light company in Tarrytown, N. Y.; one 65 h. p. non-condensing tandem compound for the Thomson-Houston International Electric Company, for foreign shipment; one 100 h. p. standard high-pressure engine for the Nordyke & Marmon Company, of Indianapolis, Ind., for an electric light plant in Indianapolis; one 45 h. p. standard engine for the Dobb's Ferry, N. Y., Electric Light and Power Company; one 40 h. p. standard engine, for Payne & Francis, of Boston, for an isolated plant in the building of the Ames estate; three 20 h. p. standard vertical engines for the Edison United Manufacturing Company, which they will install in three of Ward's line of steamships, besides a number of engines to be used in driving manufacturing establishments. The firm has enlarged its manufactory twice this year, and is now about to begin building again to get more room for additional machinery and more space for erecting. W. T. H.

PERSONALS.

Mr. J. S. Scoville, of Cleveland, has transferred his services from the National to the Globe Carbon Company.

Mr. B. Blum, the general manager of the Wenstrom Northern Electric Company, has his office at 5 and 7 Dey street.

W. E. Frick, representing Jno. A. Roeblings Son's Co., Trenton N. J., registered at the Stillman House, Cleveland, Friday.

Prof. Elihu Thomson has returned home from Europe, greatly pleased with his reception there and with what he saw.

Mr. F. de Marsac, superintendent of Indian government telegraphs, and member of the English Institution of Electrical Engineers, is on a visit to this country, inspecting American telegraphs and other electrical matters.

The Rev. Hugh O. Pentecost lectured last Sunday evening in Nilsson Hall on "Murder by Law" in presence of a large audience. "One would suppose it impossible," said he, "to get a scientific man to kill a fellow-being by electricity."

Mr. T. A. Edison and wife left for Europe on August 10 on the steamer "Bourgogne." Mr. F. R. Upton and wife were also passengers. The party were seen off by a large number of friends, who brought flowers in abundance. Mr. Edison goes to the Paris Exposition.

Mr. E. H. Johnson has gone to Niagara Falls to attend the convention of the Association of Edison Illuminating Companies, and introduce his successor, Mr. J. B. Herrick, to such of the delegates as that gentleman has not already met. Although Mr. Johnson now devotes all his time to the Sprague Motor Company, of which he is president, and is no longer an officer of the Edison parent company, he is as popular as ever with the superintendents and managers of the local companies, and will have a hearty welcome at Niagara.

BUSINESS NOTICES.

All Electricians who *are using* or *have used* Schieren's electric perforated belts say that they "take the cake" for running on dynamos.

Battery Cut-Out.—Attention is called to a simple device for disconnecting gas-lighting batteries if accidently grounded. It is cheap, sensitive, never needs watching, and has no clockwork to be kept wound. Terms furnished by the Electric Supply Company, of Syracuse, N. Y., No. 105 South Warren street.

Perforated Belts run *smoother*, with *less* strain on *dynamo bearings*, and with the use of *less oil*, than any other belts made. They also *prevent air cushions*. Chas. A. Schieren & Co. (Manufacturers), New York, Chicago, Boston, Philadelphia.

Patterson, Gotfried& Hunter (Limited), 146-148 Centre street, carry a complete stock of Brush copper, celluvert fibre, oiled paper, hard rubber, rod and sheet brass, brass, copper and iron wire, self-hardening tool steel, set and cap screws, machine bolts machine and wood screws, taps and dies, files and twist drills blowers and forges, machinery, tools and hardware, gear wheels wood pulleys, shafting hangers and belting. General factory supplies.

The Electro-Medical Guide.—Furnished gratis to each purchaser of a Smith and Shaw close cell pocket battery; will be found to be a very convenient and valuable reference book as to the diseases in which electricity is applicable and the method of using the same. We would also call attention to the new "Triplex" Batteries, which having three cells so arranged as to be used either separately or together, thus producing a current from the mildest to the strongest, should render this an exceptionally useful Battery for the Physician. Send to Henry Schwindt, 435 Seventh Ave., for circulars.

Spencer Damper Regulators.—Mr. G. G. Stillman, of 19 Pearl street, Boston, announces the following recent sales of regulators: United Electric Light Company, Springfield, Mass.; Leominster Electric Light Company, Leominster, Mass.; Andover Electric Light Company, Andover, Mass.; Langham Hotel, Boston, Mass.; Fiske Building, Boston, Mass.; West End Railroad motor station (second order), Allston, Mass.; Narragansett Electric Light Company, Providence, R. I.; Bristol Electric Light Company, Bristol, R. I.; Fenwick Hall, Saybrook, Conn.; Stamford Electric Light Company, Stamford, Conn.; Waterbury Electric Light Company, Waterbury, Conn.

The Rogers Fire Alarm.—The Rogers auxiliary alarm having been connected in Boston with many of the principal hotels, steamship docks, horse car stables and shops, breweries, factories and warehouses, commended itself to the Department of Public Buildings as an important safeguard in case of fire or other accident in the public school houses, as it enabled instant alarm to be sounded from every room, if for any reason assistance was required. What is thought of the system may be judged from the following letter from Superintendent of Public Buildings Tucker, who says: "In reply to your letter of the 12th inst., I would say that I thoroughly believe in the 'Rogers' auxiliary fire alarm system so much so that I have applied it to one hundred of our school houses. There is no question that the presence of this system in the Gaston school house, South Boston, saved the roof of said building from destruction by fire some two months since."

The Aluminum Brass and Bronze Company, of Bridgeport, Conn., have opened an office in New York City at 261 Broadway, corner of Warren street. Mr. S. B. Hawley is their representative in charge, and he is also one of the directors of the company. They control throughout the United States the aluminum and silicon copper alloys made by the Cowles electric smelting furnace, and are now prepared to fill promptly all orders for silicon bronze trolley wire, which has been a valued part of the Sprague street car system for many months. Smaller sizes will be ready soon The casting department is also in working order,and is turning out sand castings of aluminum bronze, aluminum brass and other aluminum alloys that are daily finding a wider application in electrical construction. When their extensive rolling mills are completed, which will be in a few weeks, sheet metal, rods and small wire of aluminum and silicon alloys will be produced in large quantities. Mr. Hawley will be glad to see at his new office any one who wishes information about the above alloys, or to send a descriptive circular on request.

Molded Mica Insulators.—Within the past year a new kind of electrical insulator has been put upon the market by the Gould & Watson Company, 110 Water Street, Boston, which has taken an important place. The substance is known as "Lehte," a composition made largely of mica. It has been widely used for the purpose of trolley-line insulators in electric street railways, and has given great satisfaction. Also, in motors, it has found a place in commutator brush yokes, which are made entirely of lehte or of iron with lehte covering. A valuable quality in this insulator is the ease with which it is attached to metal. Used as an insulative covering, or molded together with metal parts for connection, the union of lehte and metal is so perfect that they cannot be parted, nor is there any possibility of separation by expansion or contraction of metal in changes of temperature. Lehte admits of the nicest molding, and reproductions do not vary by the one-thousandth of an inch. There is practically no limit to the forms it may be worked into, and boring for holes or countersinks is avoided by providing for all such in the dies. Articles to be made in lehte are subjected in the process to a very heavy pressure, which gives alike strength and great denseness to them, and bring out exactly the finest lines of the dies, of screw-threads, etc. While it is not intended for high temperatures, lehte bears the greatest cold without becoming brittle, and being unaffected by weather is highly suitable for outside work. As it is not oxidizable, there is no loss of strength, and there is no disintegration, as in insulating substances which contain sulphur. Other uses to which lehte has been applied are for handles, bases, switch-boards, bushings, washers, etc., etc. Another kind of insulating material made by this firm is called "Morewhite." It is intended for objects required to stand higher temperatures. "Morewhite" is also molded under high pressure and is strong and durable. It does not admit of work into such highly exact forms as lehte, but can be furnished in shapes which are not too complicated. Articles like these have already proved their great value and service, and their general adoption will ollow wherever they are kn own and their qualities understood.